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GENERAL ACCOUNTING OFFICE WASHINGTON DC PROCUREMENT --ETC F/8 5/3  
CONTROLLING FEDERAL COSTS FOR COAL LIQUEFACTION PROGRAM HINGES --ETC(U)  
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BY THE COMPTROLLER GENERAL

# Report To The Congress

OF THE UNITED STATES

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## Controlling Federal Costs For Coal Liquefaction Program Hinges On Management And Contracting Improvements

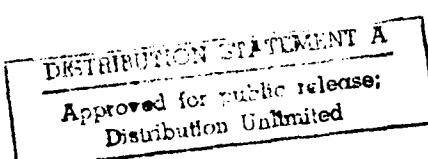
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Two pilot plants to demonstrate direct liquefaction processes for producing synthetic liquids and solids from coal became operational during 1980. The plants were financed jointly by the Federal Government and private industry. The Federal Government's share of the cost of one plant was 87 percent; on the other, costs were shared equally. Construction of two more larger facilities is scheduled to begin in 1981. Foreign government investment is high in one plant but private contractor investment is low for both.

Both operational pilot plants encountered design and construction problems attributable to DOE's premature commitment to contracting and to poor construction and contract administration by the contractors. The problems greatly increased cost and schedule slippages. Should similar problems be encountered on the planned demonstration facilities, costs to the Federal Government could be enormous.

GAO makes recommendations to DOE to control cost growth and management of future coal liquefaction and other energy projects and to enhance the prospects for successful future commercialization.

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COMPTROLLER GENERAL OF THE UNITED STATES  
WASHINGTON, D.C. 20548

B-199294

To the President of the Senate and the  
Speaker of the House of Representatives

This report points out the need for the Department of Energy to have better controls over its coal liquefaction program. It should be of interest in view of recent legislation (Public Law 96-294) which established the Synthetic Fuels Corporation to financially assist in the development of synthetic fuels, including coal liquefaction.

We are sending copies of this report to the Director, Office of Management and Budget; the Secretary of Energy; and interested congressional committees.

A handwritten signature in black ink, appearing to read "James A. Risch".

Comptroller General  
of the United States

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COMPTROLLER GENERAL'S  
REPORT TO THE CONGRESS

CONTROLLING FEDERAL COSTS  
FOR COAL LIQUEFACTION  
PROGRAM HINGES ON MANAGEMENT  
AND CONTRACTING IMPROVEMENTS.

D I G E S T

Coal liquefaction is the process of converting pulverized coal into synthetic fuels as a substitute for petroleum products. Four direct liquefaction processes have been developed: H-Coal, Exxon Donor Solvent, Solvent Refined Coal-I, and Solvent Refined Coal-II.

None of the processes will be commercialized until the late 1980s or thereafter. Commercial plants would be built to process between 17,000 and 30,000 tons of coal a day. Each process is expected to produce the equivalent of three barrels of liquids from a ton of coal.

The two largest existing coal liquefaction facilities (H-Coal and Exxon Donor Solvent) are classified as pilot plants. They can process between 200 to 600 tons of coal a day. Construction of these plants was completed in December 1979 and March 1980, with operations starting in 1980.

Two Solvent Refined Coal pilot plants have been operational since 1974, but they process only 6 to 50 tons a day. Two plants, classified as demonstration plants, are under design with construction to start in March 1981 and operations in October 1984. These plants will be sized to process up to 6,000 tons a day.

PROBLEMS ENCOUNTERED WITH  
H-COAL AND EXXON DONOR  
SOLVENT PILOT PLANTS

The Department of Energy's (DOE's) estimated total costs for the H-Coal and Exxon Donor Solvent pilot plants show each will exceed their baseline estimate covering research and design, plant construction, and operations by 66 and 24 percent, respectively.

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The H-Coal baseline estimate was \$178.8 million and is presently projected at \$296.1 million. The Federal Government's share is about 87 percent of the total predicted cost. The Exxon plant baseline estimate for liquefaction was \$225 million and is now projected at \$279.5 million. The Federal Government's share is 50 percent. (See pp. 11 and 12.)

Both the H-Coal and Exxon projects experienced engineering cost growth in designing the plants and changes during construction because of the concurrency between design and the construction work. Problems associated with H-Coal were of greater severity and magnitude. GAO believes that the problems encountered at H-Coal began when the Federal Government was unable to obtain adequate sharing of risks by private sponsors in this venture. (See pp. 13 and 14.)

DOE FAILED TO PROPERLY  
DEFINE AND CONTROL WORK  
ON THE H-COAL PROJECT

DOE contractual agreements with the prime contractors were made before the design scheme for the H-Coal plant was complete. For example, the initial construction and operations contract was signed when the design package was only 20 to 25 percent complete. As a result, the scope of work to be performed could only be general in nature and estimates had no sound basis. (See pp. 17 to 19.)

In the administration of the H-Coal contracts, GAO found that DOE:

- Delegated administration of prime contracts to other prime contractors, DOE program offices, and other Federal agencies. (See p. 20.)
- Failed to make modifications part of the contract in a timely manner. (See pp. 20 and 21.)
- Did not exercise adequate control over the construction change order system. (See pp. 21 to 23.)

--Permitted the contractor for construction to award a large number of subcontracts and to engage in unacceptable Federal subcontracting practices. (See pp. 23 and 24.)

--Did not perform timely audits of contractor cost. (See pp. 24 and 25.)

CONTRACTORS INVOLVED IN POOR  
AND QUESTIONABLE CONSTRUCTION  
PRACTICES

In the construction of the H-Coal pilot plant, several problems resulted from poor judgment and lack of management and controls over the project by DOE and contractors. Collectively, the problems substantially increased cost and schedule slippages. They included:

--Starting construction before enough of the detailed design and construction schedule were complete. (See pp. 26 and 27.)

--Low labor productivity and the need to import craft labor. (See pp. 27 and 28.)

--Improper property acquisitions and the lack of controls over such property. (See pp. 28 to 32.)

--Equipment cost not minimized. (See p. 32.)

--Inadequate quality control. (See pp. 32 and 33.)

--Excessive project overhead. (See pp. 33 and 34.)

--Building beyond the needs of the pilot plant. (See pp. 34 to 39.)

PLANS FOR SOLVENT REFINED  
COAL DEMONSTRATION PLANTS

DOE plans to construct two Solvent Refined Coal demonstration plants. The estimated cost of these plants have significantly increased over the original estimate of \$685 million each. After preliminary design, the costs were reestimated by DOE contractors to

about \$1.9 billion for Solvent Refined Coal-I and \$1.4 billion for Solvent Refined Coal-II. These estimates did not contain any provision for contingencies, escalation, or potential product revenues. With contingencies and escalation included, the estimated cost is \$3.1 billion for Solvent Refined Coal-I and \$2.7 billion for Solvent Refined Coal-II. Potential product revenues which would offset a portion of these costs were not included in these estimates. Later estimates prepared by DOE and its contractors show each project at \$1.4 billion. However, this takes into account potential product revenues but omits the cost of contingencies and escalation during the 5-year operations phase. GAO believes that complete cost estimates are critical to future decisions on these plants.

Investment by private U.S. sponsors is only about \$100 million for each project. Foreign investment interest is limited to the one plant on which both the Federal Republic of Germany and Japan are each expected to contribute 25 percent of the project cost.

Should the problems of the H-Coal project be repeated on these large scale demonstration plants, the cost could be enormous. DOE has told GAO that it has taken steps in planning for these two projects to avoid past pitfalls. DOE should be concerned, however, about the small percentage of private investment by U.S. sponsors. It should also be concerned about concurrency in the design and construction schedules. (See pp. 40 to 43.)

Another concern is the risk involved in scaling-up from 50 tons a day (largest Solvent Refined Coal pilot plant) to 6,000 tons a day commercial-sized modules. The H-Coal and Exxon Donor Solvent developers believe the normal progression in process development is to make commercial decisions based on the successful operation of plants processing about 200 to 600 tons a day, thus eliminating the need for demonstration plants. DOE believes that the Solvent Refined Coal commercial-sized modules will remove any doubts about the value of all liquefaction processes. (See p. 44.)

AGENCY AND CONTRACTORS  
COMMENTS

This report was reviewed by DOE and contractors who were affected by statements in the report. DOE was not in total agreement and stated that the report contained statements which were in error or could be misinterpreted. Meetings with DOE officials resolved these issues. DOE stated the report accurately identifies and describes the problem areas and, in that sense, is quite useful. However, the draft report did not consider DOE's actions to mitigate many of the noted problems. DOE stated that recently completed actions, utilizing lessons learned on past and present projects, should assure better direction and management of these projects. One contractor generally agreed with the report. Another disagreed and provided specific comments on 10 issues. GAO generally disagrees with this contractor's comments because no persuasive evidence was presented.

DOE and contractor comments in their entirety and GAO notes relating to them are in appendices I through IV.

CONCLUSIONS

GAO's review of the H-Coal and Exxon projects showed inadequacies in DOE's contracting practices and a failure by DOE to properly plan, manage, and monitor, especially the H-Coal project.

The initial Government-industry H-Coal agreements regarding the level of investment by private sponsors and the ceilings imposed on sharing in cost growth were imbalanced. Larger investments by private sponsors and sharing of cost growth provides an incentive to private sponsors to control costs and helps to assure that each party is fully committed to the success of the project.

DOE started the H-Coal project prematurely before sufficiently detailed designs were

available and without adequate project planning for functions such as construction scheduling, materials handling, inventory systems, and quality control. DOE staffing was inadequate at both projects to effectively monitor progress and contribute to timely decisions. Its contracts for the H-Coal plants were poorly written and administered. DOE plans for the two large demonstration plants need careful review and attention in light of escalating cost and the risks involved in scaling up to the 6,000-ton-a-day facilities.

The projected costs together with such other factors as economics, environmental, and chances of commercial success are key considerations in deciding if both processes warrant support in view of competing technologies.

RECOMMENDATIONS TO THE  
SECRETARY OF DOE

The Secretary of DOE should:

- Assure that projects are properly planned and designed sufficiently before they are started to avoid disruptions and to hold design changes to a minimum.
- Provide adequate DOE support staff to monitor the various phases of its projects and to assure that management tasks such as property control, inventories, subcontracting, and so forth, assigned to private industry are done within regulations and with adequate management controls.
- Establish a format for existing monthly project reports (prepared by contractors) to provide data needed by DOE to effectively monitor the projects.
- Encourage the use of fixed-price contracts when it becomes practical for the contractors to define their remaining efforts and quantities required.

To enhance the prospects for successful future commercialization and lessen the Government's

financial burden, the Secretary of DOE should obtain a more equitable cost sharing commitment from private sponsors for all phases of energy projects to assure they share in the risks and fully apply their expertise toward assuring sound management, including adequate controls over cost and schedule.

The Secretary of DOE should also provide to the Congress an assessment of the effect that the escalating costs of the Solvent Refined Coal plants and the risks involved in scaling up to the 6,000-ton-a-day facilities, along with other relevant factors, will have on the feasibility and affordability of both projects and the ability of DOE to reach its program objectives.

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<u>ABBREVIATIONS</u>	
DCAA	Defense Contract Audit Agency
DOE	Department of Energy
EDS	Exxon Donor Solvent
GAO	General Accounting Office
SRC	Solvent Refined Coal

## CHAPTER 1

### INTRODUCTION

Because of the importance of liquid fuels to the U.S. economy, the increasing cost, and the questionable availability of foreign supplies, the Federal Department of Energy (DOE) <sup>1/</sup> is supporting the parallel development of four processes to convert pulverized coal into synthetic liquid and solid fuels. This conversion involves a chemical reaction based on increasing the ratio of hydrogen to carbon found in coal. Fuels produced through coal liquefaction can replace petroleum refined products such as boiler fuels, heating oils, chemical feed stocks, and naphtha which is further refined into gasoline.

The four processes under development are H-Coal, Exxon Donor Solvent (EDS), and two similar but distinct applications of Solvent Refined Coal (SRC) technology. Each is referred to as direct hydrogenation since the coal is mixed or slurried in a stream of liquids and reacted in an atmosphere of hydrogen under high temperature and pressure. All four processes are similar in reaction time, temperature and pressure conditions, and complexity of plant hardware. Each process, however, has a different approach to supply the hydrogen to the coal molecule. Each process, based on years of testing, is expected to produce about the equivalent of three barrels of liquids per ton of coal. This level of production is twice that of South Africa's operational liquefaction plant which uses a different technology than the U.S. developed processes.

#### H-COAL

H-Coal has been under development by Hydrocarbon Research, Inc., since the late 1950s. It is based on the commercially used H-Oil process. A number of sponsors have been in the program including periods of participation by

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<sup>1/</sup>The Office of Coal Research, Department of the Interior, was the principal Government research entity initially involved in converting coal to synthetic fuel. All functions and personnel of this office were subsequently transferred to the Energy Research and Development Administration, which then became a part of DOE on October 1, 1977.

the Federal Government through the Office of Coal Research and more recently by DOE.

H-Coal has progressed from a small laboratory unit processing 3 tons a day to a large 200 to 600-ton-a-day pilot plant. Construction of the pilot plant at Catlettsburg, Kentucky, was completed in December 1979. Operations using coal began in 1980 and are to be completed in December 1981. Two additional years could be added to the program.

The pilot plant program had 10 sponsors (later reduced to 7) and included DOE, private industry (coal and oil), an electrical power research institution, and a State government. The pilot plant program has an estimated completion cost of \$296 million. The Federal share of this program may be as high as \$258 million or about 87 percent of the predicted final costs. Commercialization is being considered as the next step and preliminary studies funded by DOE and private industry have started.

EDS

The EDS process was developed by Exxon Research and Engineering Company (Exxon) as a private venture from 1966 until 1976, consisting of small-scale laboratory units and design work. In 1976 DOE became involved in the project and later through a cooperative agreement arranged to share in 50 percent of the costs of a 250-ton-a-day pilot plant. Under this agreement, Exxon was permitted to bring in additional private sponsors to meet its 50-percent requirement. At first, only two additional sponsors were added, but this was later supplemented by three other firms including two foreign companies.

Construction of the pilot plant at Baytown, Texas, was completed in March 1980 and is to be followed by a 30-month operational program. An option for 2 additional years of operations is available. Pilot plant cost for liquefaction only is estimated at \$279.5 million through the initial operational program. An additional \$79.8 million has been committed to the EDS program for the development of a process to further refine the unused process liquids and unreacted coals (bottoms development). Bottoms processing is a unique feature of the EDS program and could be applied to other liquefaction processes.

Like H-Coal, commercialization is considered to be the next phase.

SRC

There are two SRC projects which are similar but distinct applications of the same technology. DOE considers both as liquefaction projects even though one of the processes (SRC-I) produces as its main product a low sulphur solid product designed for use as a boiler fuel. Increasing the severity of this process by application of additional hydrogen produces a liquid fuel (SRC-II).

Federal involvement in SRC began in 1962 under an Office of Coal Research contract with the Spencer Chemical Company which was later purchased by the Gulf Oil Corporation. Under this contract, the feasibility of the solid process was tested in a 1/2-ton-a-day unit. A follow-on contract resulted in the construction (beginning in 1972) of a 50-ton-a-day pilot plant at Fort Lewis, Washington, again demonstrating the solid process. This small-scale pilot plant began operations in September 1974. It was later converted to the liquid fuel mode operation processing 30 tons a day. This project has been totally funded by the Federal Government, and through fiscal year 1980, the cost will be about \$130 million.

Additionally, a joint private venture (Southern Company Services Incorporated and Electric Power Research Institute) built a 6-ton-a-day pilot plant at Wilsonville, Alabama, to produce SRC-I or the solid product. Operations of this small pilot plant began in 1974. DOE became a cosponsor in this venture in 1976 and by the end of fiscal year 1980 will have funded \$21 million. Private sponsors will have contributed over \$8 million.

In late 1979, DOE entered into contracts for the detailed design of demonstration facilities (one module of a commercial facility) for both SRC-I and SRC-II. Both plants are to be sized to process about 6,000 tons a day with construction scheduled to begin in March 1981. The operational phase is a 5-year period for both plants and is scheduled to start in October 1984. After preliminary design, the SRC-I and SRC-II projects were estimated to cost about \$1.9 billion and \$1.4 billion, respectively. Neither estimate was adjusted for contingencies, escalation, or product revenues. Adjustments for contingencies and escalation result in the estimates being \$3.1 billion for SRC-I and \$2.7 billion for SRC-II. Revenues from the sale of the product would offset a portion of this cost. The latest DOE and contractor estimates which decrease costs because of potential product revenues are \$1.4 billion for each SRC plant. This estimate, however,

does not include contingencies or escalation for the 5-year operations phase.

Commercialization would be the next phase by adding more modules.

#### DEVELOPMENT STATUS

None of the four direct coal liquefaction processes is developed to the point of commercial readiness. Before 1980, the largest operating plant was only processing 50 tons a day. This is a small quantity when considering that an economical commercial plant would be required to process between 17,000 to 30,000 tons of coal a day.

DOE's strategy has been to support all four processes through their development stages to produce the data needed by private sponsors to make commercial decisions. Although DOE's level of funding has differed on each project, no one process has received any more favorable treatment than the others. Its strategy is to avoid relying solely on one process to succeed and to protect against erosion in development interest that could occur should private sponsors find more lucrative financial alternatives.

The large scale H-Coal and EDS pilot plants began operations in 1980. The private sponsors of these plants believe the data, experience, and knowledge gained at the plants will allow them to bypass the demonstration phase and move directly toward a commercial venture. H-Coal sponsors appear to be more optimistic with a commercial venture by doing the planning and construction in the early 1980s and increasing the processing to about 17,000 tons of coal producing 50,000 barrels a day by 1987. In contrast, Exxon believes it will be about 1997 before it has an operating facility with this type of capacity. A DOE official told us these scheduled projections for building and operating commercial liquefaction plants were too optimistic for H-Coal and maybe too pessimistic for EDS.

The two SRC projects have a different development pattern than either H-Coal or EDS. Whereas the latter two projects have large pilot plants, SRC has much smaller facilities. The next progression for both SRC projects is to a demonstration plant representing one commercial module processing about 6,000 tons of coal a day. The SRC demonstration plants are not scheduled for operations until late 1984. After the successful and satisfactory operation of one module each for SRC-I and SRC-II, the processes would be ready for commercialization.

### OBJECTIVES, SCOPE, AND METHODOLOGY

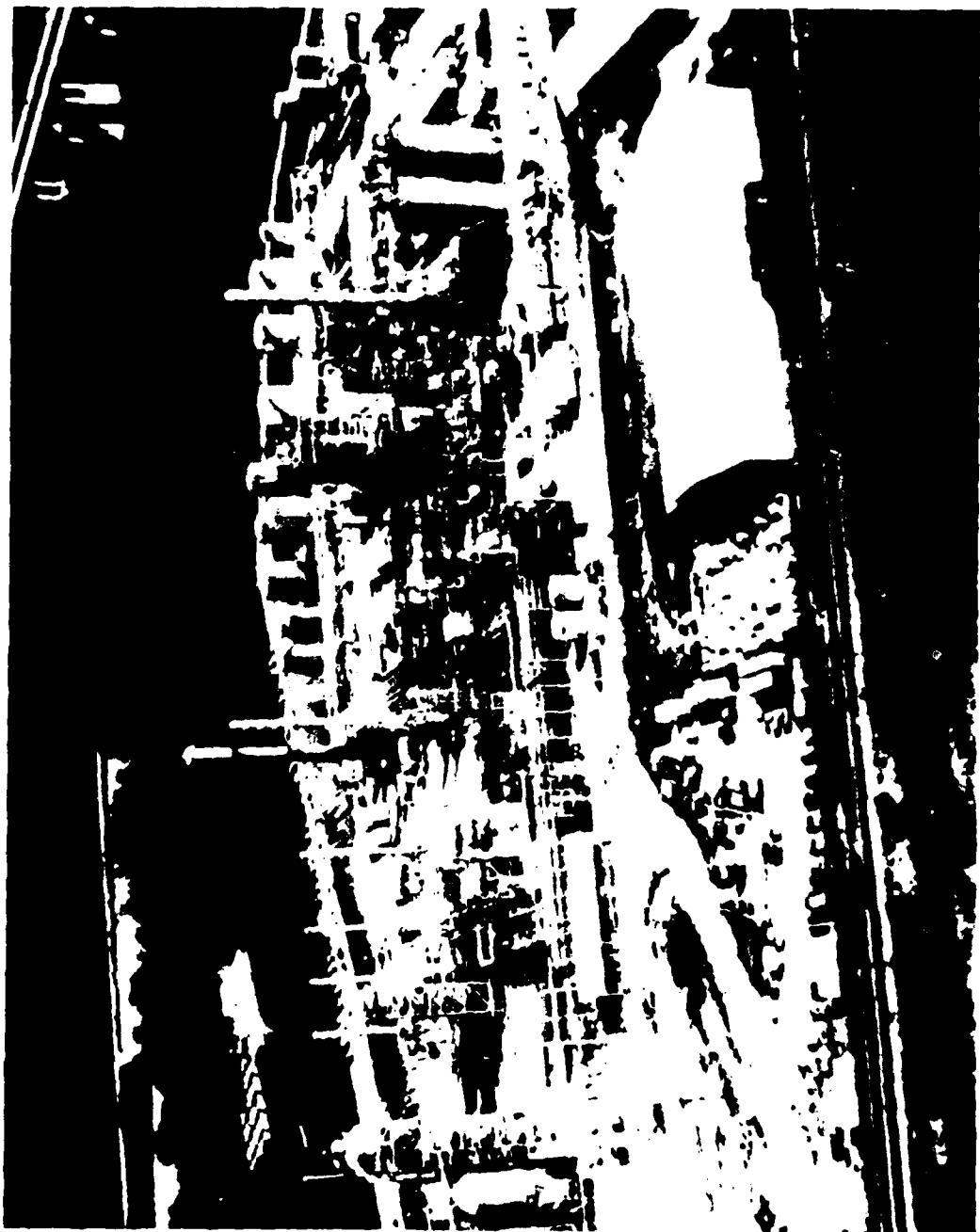
Our review involved four coal liquefaction processes which are being developed by joint DOE, private industry, and foreign sponsorship. Their stage of development, predicted cost, and schedule plans leading toward commercialization were covered for each process. However, emphasis was given to the completed construction programs for the two largest existing pilot plants--H-Coal and EDS (see photographs on pages 7 and 8 showing their size and complexity). This review of the two pilot plants was intended to:

- Examine Government and private industry contractual agreements with emphasis on the financial participation and managerial responsibilities of each of the participants.
- Compare project cost and schedule baselines to the current estimates and to report on reasons these performance parameters were met or exceeded.
- Report on managerial, contractual, and poor construction practices which need to be addressed in future and more costly energy projects. This especially relates to planned construction in 1981 of multibillion dollar SRC-I and SRC-II coal liquefaction demonstration plants.

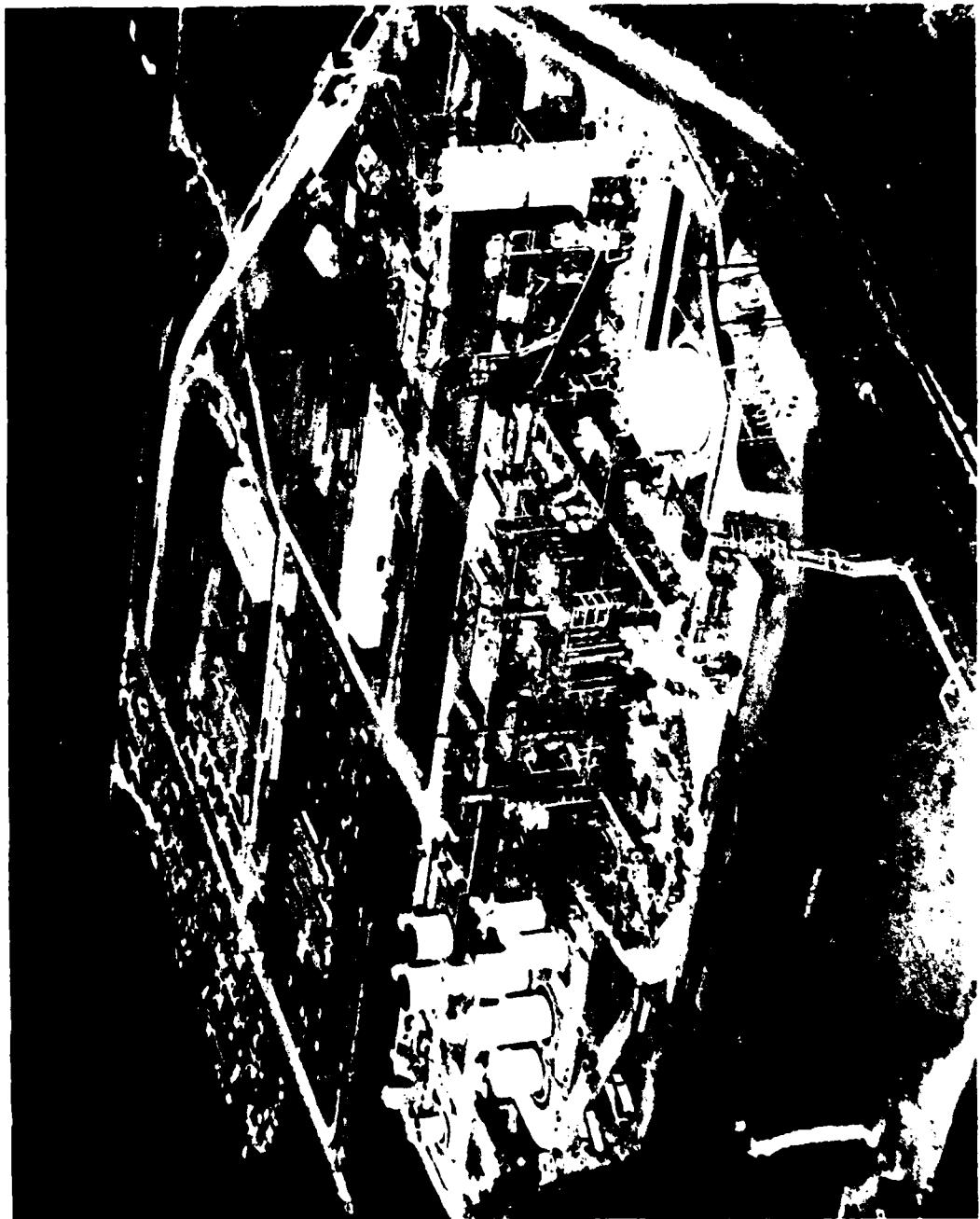
At both pilot plant projects, we examined construction performance in respect to overall organization, labor productivity, material handling, controls over equipment, subcontracting, and quality control. We held discussions concerning the above activities with DOE and private industry officials. At the EDS project, we found these activities to be well documented and within the norm in the construction industry. In contrast, the H-Coal project was extremely difficult to review because of poor and inadequate record-keeping practices by DOE. Often the only complete records for certain project activities remained in the custody of the participating contractors. Because this situation existed on this project, it became necessary to have contractors provide written responses to our inquiries and attach supporting documents.

We addressed DOE plans for the two SRC demonstration plants and their application of lessons learned, especially on the H-Coal project. We examined varying cost estimates which could eventually affect the affordability of both projects.

At the conclusion of this review, we gave copies of the draft report to DOE and four private companies involved in the research, design, construction, or operations of the H-Coal or EDS pilot plants for comments. We received replies from DOE and two companies, and their comments and views were considered and, where appropriate, incorporated into the report. Each reply is included in its entirety and followed by our notes on these individual responses. (See apps. I to IV.) Two companies declined to comment.



H-COAL PILOT PLANT 200-600 TONS PER DAY CATLETTSBURG, KENTUCKY



EXXON DONOR SOLVENT PILOT PLANT 250 TONS PER DAY BAYTOWN, TEXAS

CHAPTER 2

PROBLEMS ENCOUNTERED WITH THE

H-COAL AND EDS PILOT PLANTS

Both the H-Coal and EDS pilot plants are expected to exceed their baseline cost estimates covering research and design, plant construction, and operations. The H-Coal baseline estimate was \$178.8 million and is presently projected at \$296.1 million for an increase of about 66 percent. The portion of the increase attributed to the construction phase is over \$54 million. It took 36 months to complete rather than the expected 20 months. The EDS pilot plant baseline estimate of \$225 million has grown to \$279.5 million for an increase of about 24 percent. The recently completed EDS construction program exceeded its baseline estimate by \$7.7 million and its schedule was exceeded by 5 months. Late in the project's construction phase, a nonliquefaction process (bottoms development), which is to be used to further treat the unused processed liquids and unreacted coal, was added at an estimated \$79.8 million.

Although both projects exceeded their construction cost and schedule baselines, the H-Coal project problems were of a greater severity and magnitude. This condition is reflected in a DOE internal assessment of various factors shown below that was made during the construction phase of both projects.

<u>Factor</u>	<u>H-Coal</u>	<u>EDS</u>
Program resources	Major improvement needed	Improvement needed
Contractor management	Improvement needed	Satisfactory
Schedule	Improvement needed	Satisfactory
Technical	Improvement needed	Satisfactory
Funding	Major improvement needed	Improvement needed
Procurement	Major improvement needed	Major improvement needed
Project objectives	Satisfactory	Satisfactory
Overall project assessment	Major improvement needed	Satisfactory

Since the H-Coal and EDS pilot plants are research and development programs, not all contingencies and unknowns can be predicted. On both projects, there was engineering cost growth in designing the plants, equipment delays, and several changes that took place during the course of construction because of concurrency between laboratory studies, design,

and the construction efforts. Also, the management committee structures established for both projects slowed the decision-making process thus delaying completion of the projects.

The most serious problems on the EDS project were the lack of DOE staffing and decision delays in funding the bottoms development program. In contrast, the problems associated with the H-Coal pilot plant were much worse. During the construction phase, conditions deteriorated to a level where little progress was being made toward the completion of construction. Assessments of the H-Coal project by DOE and hired consultants identified the following as major causes for the cost growth and schedule extensions:

- Incomplete original scope of the project.
- Quantities not well defined.
- Inadequate DOE site support staff.
- Complex contract structure and poor administration.
- Lack of financial controls over contracts.
- Abnormal error rates in design.
- Low labor productivity.
- Excessive construction rework.
- Disharmony among major contractors.

Our examination confirmed that the above factors severely impacted the H-Coal project. The problems encountered on the H-Coal project began with the initial agreements in which the Federal Government failed to obtain adequate sharing by private sponsors in the risks for this venture. Because DOE was under severe pressure to start the project, the initial agreements were not fully protective of the Government's interest. DOE insisted, for example, that construction be started and a work force be mobilized in the middle of winter although the involved contractors objected.

In the early phases of construction, designs were still incomplete, thus preventing orderly construction progress. During this early construction phase, relations among DOE, the private participants, and the general contractor became so strained that little construction progress was achieved. At this same time, the productivity being achieved from the labor work force was well below normal expectations.

DOE eventually took a more active role in the project with additional people assigned to the project including construction consultants. By this time, however, the damage had occurred and the mode of operations had been established and ingrained between the contractors and labor work force.

#### COST

The baseline estimates for the H-Coal and EDS pilot plants covering research and development, construction, and operations for liquefaction will be exceeded by 66 and 24 percent, respectively. This is contingent on the operations phase being completed within current predicted final costs. The comparison of baselines and predicted final costs is shown in table 1. Over half of the EDS total program increase is due to a nonliquefaction process (bottoms development).

Table 1  
Pilot Plant Cost

<u>Phase</u>	<u>H-Coal</u>		<u>EDS</u>	
	<u>Base- line</u>	<u>Predicted final</u>	<u>Base- line</u>	<u>Predicted final</u>
----- <u>(millions)</u> -----				
<b>Liquefaction:</b>				
Research & design	\$ 24.7	\$ 31.7	\$ 52.5	\$ 70.9
Construction	86.3	140.4	110.3	118.0
Operations	<u>67.8</u>	<u>124.0</u>	<u>62.2</u>	<u>90.6</u>
Total	178.8	296.1	225.0	279.5
Bottoms development	<u>-</u>	<u>-</u>	<u>15.0</u>	<u>79.8</u>
Total program	<u>\$178.8</u>	<u>\$296.1</u>	<u>\$240.0</u>	<u>\$359.3</u>
Total liquefaction increase		66%		24%
Total program increase		66%		50%

H-Coal will exceed its baseline estimate of \$178.8 million by at least \$117 million. Its completed construction program had cost growth of over \$54 million. The baseline for the H-Coal pilot plant was made in mid-1976. It was a premature estimate based on an incomplete scope of the project. The project was reestimated several times. In

July 1978, or 18 months after the start of construction, it was estimated at \$266.3 million. This was followed by a \$285.4 million estimate in December 1978 and the current predicted final cost of \$296.1 million developed in March 1979.

The EDS baseline estimate of \$240 million including \$15 million for nonliquefaction costs associated with bottoms development was made in July 1977. As shown in table 1, the largest increase to the EDS project is attributable to bottoms development which is intended to increase yields from the unused processed liquids and unreacted coals. The initial expenditures for bottoms development were for laboratory and engineering studies. The majority of the increase to the project cost is for the modification and operation of equipment which will occur between 1980 and 1982.

#### Cost forecasting differences

The construction program to build the H-Coal pilot plant was never adequately estimated. From the beginning, man-hours, quantities of materials to be erected, and the predicted final costs were being recasted monthly. The project underwent several reassessments which added millions of dollars to the predicted final costs of construction. Coupled with these constant reassessments was the use of an irregular measuring system to assess progress based on man-hours a ton. The U.S. construction contractors do not normally use this method and, because DOE and its consultants were unfamiliar with it, they made no independent evaluation and accepted the construction contractors assessment of progress.

In contrast, the EDS construction program baseline estimate of \$110.3 million was made by Exxon in July 1977. As shown in table 1, the estimate of final construction costs made in March 1980, nearly 3 years after the establishment of the baseline, was \$118.0 million or \$7.7 million above the baseline.

The predicted final costs for the operations phase of the H-Coal and EDS pilot plants are 83 percent and 46 percent, respectively, above their baselines. The predicted final cost for the operation of the H-Coal project is estimated to be about \$33 million more than for EDS. It should be noted that H-Coal does use a larger capacity during part of its operations at 600 tons a day (26 weeks), but overall the EDS operations are for 30 months compared

to 24 months for H-Coal. In reviewing the estimates for H-Coal operations, we noted that about \$31 million was for reserves (contingencies), including \$10 million for equipment modifications. In contrast, the EDS operations estimate contains only \$2 million for equipment modifications. An H-Coal contractor official told us their operational budget contained many contingencies because of all the problems and criticisms over the recently completed construction program.

#### Exclusion of consultant cost

The total predicted final costs for the H-Coal pilot plant excludes at least \$3.0 million incurred for several consulting groups used on that project. Although these particular costs were charged in full to DOE and not subject to cost sharing with the private sponsors, they represent direct costs and should be part of the total program costs. To do otherwise, would underestimate project costs.

#### Contrast in Government-industry agreements

The Federal Government's financial participation in these pilot plants ranges from 50 percent on EDS to about 87 percent on H-Coal. At the inception of these projects, it was DOE's internal policy to obtain at least 33 percent of the funding from private industry. This was not achieved in negotiating the agreement for the H-Coal project. We believe the problems encountered at the H-Coal project began when the Government obtained only a 20-percent funding from private industry (later reduced to 13 percent because of cost-sharing ceilings).

The H-Coal project was structured within standard contractual agreements between the Federal Government and the private industry which formed a consortium of nine private sponsors. The Federal Government agreed to fund \$144.0 million, or 80 percent of the total project baseline of \$178.8 million; the private sponsors collectively agreed to fund the remaining \$34.8 million which included about \$6 million for the research and design phase. Private sponsors were protected from sharing in potential project growth by a cost-sharing ceiling which limited their collective contributions to \$38.0 million, or \$3.2 million above their initial level. With the predicted final costs at \$296.1 million, DOE will fund nearly all of the \$117 million cost growth which would bring the Federal participation to \$258 million, or 87 percent of the total project.

In contrast, the EDS project is based on a cooperative agreement between the Federal Government and Exxon. The Federal Government was responsible for 50 percent of the original baseline estimate. In turn, Exxon was permitted to form a consortium of private sponsors to meet its 50-percent requirement. The purpose of the cooperative agreement was to permit Exxon to conduct this project in the same manner as if it was exclusively its own. Unlike H-Coal where sharing in cost growth is basically nonexistent, EDS participants share equally with DOE in such growth. No one is forced to share in cost growth except for the fact their ownership rights could be reduced by not participating. DOE's initial share in the EDS project was \$120 million including the initial bottoms development effort. Under the current predicted final cost, DOE's share will be about \$180 million.

#### SCHEDULES

Both the H-Coal and EDS processes have been under Government or privately funded research and development for over a decade. Using detailed design as the start for these two pilot plants, the EDS program will be a 5-year effort through its initial 30-month operational phase. In contrast, H-Coal through its 24-month operations phase will be a 7-year effort. Both projects took longer to design than originally predicted and construction for H-Coal was a 36-month effort compared to 26 months for EDS. As shown in table 2 below, construction of the H-Coal pilot plant started 1 year before EDS; yet both plants are entering their respective operational programs nearly at the same time.

Table 2  
Pilot Plant Schedules

	<u>H-Coal</u>	<u>EDS</u>
Detailed design start (actual)	Jan. 1975	Sept. 1977
Detailed design completion (baseline)	Dec. 1976	Feb. 1979
Detailed design completion (actual)	Feb. 1978	June 1979
Construction start (actual)	Jan. 1977	Feb. 1978
Construction completion (baseline)	Sept. 1978	Nov. 1979
Construction completion (actual)	Dec. 1979	Mar. 1980
Operations start including commissioning	Jan. 1980	Apr. 1980
Operations completion	Dec. 1981	Sept. 1982

#### COMMITTEE MANAGEMENT

Both the H-Coal and EDS projects operated within committee structures. Several key committees were established on each project with membership including the multiple private participants and DOE. Voting strength on the key program committees was based on the level of financial commitment to the project. In essence, DOE has the major influence in the H-Coal project, but shares it equally with Exxon and others in EDS. DOE chaired the key H-Coal committees, while Exxon did so on EDS.

Through the cooperative agreement, Exxon basically retained the right to manage and control the EDS project in the same manner as their other private ventures. Exxon was required, however, to obtain committee approval for items that changed the scope of work, annual budget, and schedule. Additionally, Exxon had its own project office of about 14 people to oversee construction or, in other words, it served in the role of construction monitor. DOE site personnel consisted of only one representative during construction supported by staff from the Defense Contract Audit Agency (DCAA).

The H-Coal management structure was nebulous and we found it subject to differing viewpoints. DOE headquarters representatives told us it was their intention to have the original construction management and operations firm fully manage those phases of the project. More than one of the private sponsors, however, told us DOE in reality exercised direct outside control of the project. One participant told us that few decisions were ever made in committee meetings, claiming that DOE made the final decisions (many of which were not documented) after private deliberations. These often resulted in delays of several months to the project.

DOE Headquarters staff managed the H-Coal project until February 1979 and as at EDS, a project manager was their only representative at the site. DCAA was assigned to provide audit service. When the project fell behind schedule, DOE began bringing in consultants and eventually reorganized the project in June 1978 keeping the same contractors, but switching their overall responsibilities. When this action occurred, it created a complex contract structure since many of the subcontractors then became prime contractors to the Federal Government. At the same time, DOE assigned construction management or oversight of the project to the same firm in charge of construction of the plant. Although DOE claimed performance was improved, it could not be substantiated by the

construction data. In February 1979 which was the latter part of construction, DOE Headquarters transferred the project management to its Oak Ridge field office. Oak Ridge was chartered to complete the construction phase, but not to investigate previous problems experienced on the project. As stated in one of the involved contractor's comments (see p. 54), DOE's Oak Ridge was able to add stability to the program.

In conclusion, the H-Coal project experienced a major reorganization that involved shifting responsibilities between contractors and an internal transfer of project management within DOE. The H-Coal project also experienced shifts in key personnel. For example, DOE had three different site project managers, two firms in charge of construction, and six to seven different construction managers all involved during the 36-month H-Coal construction effort. Within this period, DOE failed to properly define and control work (ch. 3) and DOE and contractors were involved in poor and questionable construction practices (ch. 4).

## CHAPTER 3

### DOE FAILED TO PROPERLY DEFINE AND CONTROL WORK ON THE H-COAL PROJECT

Federal Procurement Regulations contain detailed rules for Federal agencies to follow when purchasing supplies and services. These regulations require agencies, such as DOE, to acquire property and services of the necessary quality and within the time needed at the lowest reasonable cost. To comply with these regulations, DOE is responsible for, among other things, awarding appropriate contracts and providing proper administration of contracts to include monitoring of contractor performance and costs.

The H-Coal project was subject to these regulations but EDS was not. Audits for compliance with above procurement regulations were limited at the H-Coal project. Because the EDS project was conceived under a cooperative agreement, Exxon and its contractors were permitted to follow their own procurement procedures and practices. DCAA reviewed the procurement practices used on EDS by the major contractors and found them to be adequate to assure proper control over purchasing, subcontracting, and expediting. Additionally, Exxon reviewed its contractor's procurement procedures and practices.

Our review of the H-Coal pilot plant project showed that DOE failed to adhere to the provisions of the Federal Procurement Regulations and, as a result, it (1) awarded poorly defined prime contracts and permitted a prime contractor to do the same and (2) did not provide adequate administration of project contracts and subcontracts. Because this happened, DOE was unable to prevent the significant cost growth and schedule slippage that eventually occurred on the H-Coal project. In contrast, we did not find this type of situation on the EDS project.

### DOE AWARDED POORLY DEFINED PRIME CONTRACTS AND PERMITTED A PRIME CONTRACTOR TO DO THE SAME

In the early phase of the H-Coal pilot plant project, DOE awarded two prime contracts: one for designing the plant and procuring selected long-lead equipment and the other for managing the construction and subsequently operating and disposing of the plant. The firm in charge of construction management subsequently awarded a subcontract

for the general construction of the plant. All were cost-type contracts.

For the H-Coal pilot plant project, this type of contract was appropriate. However, neither of the prime contracts nor the subcontract referred to above included a completely or adequately detailed scope of work to be accomplished. The scope of the design contract limited the procurement by that contractor to selected but unspecified long-lead equipment components of a general utility nature, and then only with DOE approval. All of the remaining equipment procurement activity was delegated to a yet unnamed general construction contractor. The scope of the contract was not only vague concerning procurement responsibility, but it was contrary to normal practices in the petrochemical industry which generally delegates all equipment procurement responsibility to the project designer. DOE later assigned responsibility for major procurements to the H-Coal designer. Within the EDS project, this procurement role was given to the engineering firm in charge of detailed design.

DOE awarded the H-Coal construction management and operations contract when the plant's conceptual design was incomplete and detailed design was only 20 to 25 percent done. DOE was not, therefore, in a very good position to define the scope of work to be accomplished under the contract. With basically the same incomplete design package, the construction management and operations firm awarded the subcontract for plant construction to a general contractor. Construction activity was then initiated even though designs were considered "soft" because of the lack of certain information to be obtained from equipment manufacturers. No detailed construction schedule existed at this time and all equipment and materials were purchased calling for expedited delivery to the site. Exxon, in contrast, had completed the EDS plant's basic design specifications and detailed construction schedule before selecting its engineering and construction firms.

DOE could have minimized contract administration problems by delaying award of the construction and operation contract until the complete conceptual design of the plant was established. Thus, changes to the contract and cost growth would have been significantly reduced.

In July 1978 when construction was about 50 percent complete, the general contractor was awarded prime construction responsibility. At this time, DOE might have had an opportunity to correct the construction contract definition problems because plant design was essentially complete.

However, they chose to execute a letter contract which simply elevated the former construction subcontractor to the position of prime contractor for construction. This letter contract merely incorporated the same inadequate statement of work as set forth in the previous subcontract.

This is a clear illustration of managing by crisis. Because of the oil embargo of 1973-74, DOE was under intense pressure to accelerate the design and construction of projects like these. The award of poorly defined cost-type contracts creates contract administration problems because they tend to generate numerous contract changes, which in turn reduce incentives to control cost as cost growth via changes is an almost certainty. Further, a pyramiding effect occurs when poorly defined cost reimbursable subcontracts are awarded. This causes contract administrators problems in evaluating and determining whether the proposed change is already required under the contract or if the changes to the contract are legitimate.

DOE FAILED TO PROVIDE PROPER ADMINISTRATION  
OVER PROJECT CONTRACTS AND SUBCONTRACTS

Contract administration is the process of enforcing the terms of contracts, controlling contract changes, monitoring contract deliveries, and approving payments. Given the cost of the H-Coal pilot plant procurement, the number of contracts and subcontracts awarded, and the fact that major contracts were awarded without fully defining the scope of work, sound contract administration practices dictate that DOE should have closely monitored contractor performance and aggressively managed all contract activity.

Our review showed that DOE did an inadequate job of contract administration. We found that DOE:

- Delegated administration of prime contracts to other prime contractors, DOE program offices, and other Federal agencies.
- Failed to make modifications part of the contract in a timely manner.
- Did not exercise adequate control over the construction change order system.
- Permitted the contractor for construction to award an excessive number of subcontracts and to engage in unacceptable subcontracting practices.

--Did not perform timely audits of contractor cost.

Administration of prime contracts delegated to others

DOE's procurement office and its contracting officers are responsible for contract administration activities. But we reported 1/ that DOE contracting officers delegated most contract administration responsibility to its program offices and other Federal agencies. The report further stated that, as a result of delegating these duties, the procurement office exercised far less control over contracts than it should because this practice did not provide for adequate separation of duties. That is, program personnel are mission oriented and their primary interest lies in accomplishing the mission rather than administering contracts.

Contract administration for the H-Coal project is no exception to this practice. From the beginning of the project, DOE program personnel have been involved daily in monitoring contractor performance and approving or disapproving changes to contracts. DOE has also contractually arranged for the services of DCAA, the Defense Contract Administration Service, and petrochemical consultants to assist with contract administration. However, this role is only advisory and their decisions regarding contracts can be reversed by DOE program personnel. In addition, DOE has gone so far as to assign responsibility for directing and monitoring the performance of certain prime contractors to other prime contractors.

Contract modifications not made in a timely manner

Because of the inadequate contract definition and the redesignation of the general construction contract from a subcontract to a prime Government contract, many contract modifications were generated. DOE did not amend contracts to include many of the modifications in a timely manner and, in some instances, it simply failed to modify the contracts as illustrated on the following page.

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1/"Department of Energy's Practices for Awarding and Administering Contracts Needs to Be Improved," EMD-80-2, (Nov. 2, 1979).

--In August 1978, shortly after DOE awarded the general contractor a letter contract designating them prime contractor for construction, a modification was issued provisionally increasing the contract price about \$20 million to reflect the contractor's proposal for completing construction. This modification and four subsequent modifications were not formally made part of the contract until March 9, 1979.

--When responsibility for plant construction was reassigned in July 1978, DOE did not modify the original construction management contract amount to reflect this change. As of May 1980, the original contract price had yet to be modified to show the change in cost.

--After DOE's Oak Ridge Operations office assumed responsibility for the coal liquefaction program in February 1979, they requested the general contractor to reestimate cost to complete construction of the project. On March 29, 1979, the contractor estimated that an additional \$20 million was required to complete construction. As of May 1980, the contract had not been modified to reflect this additional cost even though the contractor's services were essentially terminated in December 1979. Furthermore, this same contract had not been modified to reflect cost increases after March 29, 1979.

Because the contracts were not amended to reflect various modifications, neither the construction nor operations contract accurately reflected the predicted final cost. Although the general construction contractor's work has been completed at a reported cost of about \$74 million, its amended contract was only for \$45 million. The operations contractor (a firm which was also construction manager for nearly 50 percent of the project) currently estimates its cost at about \$160 million, yet its contract is only for \$125 million. This contract price still (1) includes construction and construction management costs which will not be incurred and should be deleted from the contract price and (2) omits some operating costs which should be added.

Adequate control over the construction change order system not exercised

Change orders are documents used to describe the nature of, reason(s) for, and the estimated cost of alterations to a contract scope of work. Change orders could be initiated by any party associated with the design, construction,

or operation of the H-Coal plant. The items covered by change orders become additions or deletions to the contract scope of work and cost.

On a construction project the size of the H-Coal plant, a number of change orders can normally be anticipated covering design changes and rework efforts. Because the design of the plant was only partially complete when the construction contract was awarded and work began, DOE should have (1) anticipated that a larger than normal number of change orders would be processed and (2) implemented control procedures to assure that all change orders were reviewed in detail before approval.

During the construction period over 500 change orders valued in excess of \$20 million were processed and incorporated into the construction contract. Our review of the change order processing system showed that DOE exercised at best only marginal control over change orders. For the majority of the construction period, responsibility for reviewing and approving change orders was delegated to the (original and successor) contractors in charge of construction management. Only changes in excess of \$10,000 (later increased to \$25,000) required DOE approval.

In December 1978 the authority of the construction management contractor (successor at this time) to approve change orders was discontinued. The Defense Contract Administration Service believed the Government should be reviewing and approving changes before completion of the construction work and felt the arrangement of having the construction management firm (successor at this time) approve changes to its own contract was in violation of Federal Procurement Regulations. By this time the majority of the change orders had been approved. After DOE became solely responsible for reviewing and approving change orders, a backlog of about 50 change orders quickly developed. Without proper review, DOE decided to approve the change orders as a group and include them as part of a modification updating the construction contract just before the time Oak Ridge assumed project management in February 1979.

In the latter part of construction, DOE's Oak Ridge management and the construction contractor reached agreement giving the contractor authority over technical changes and requiring approval only for material changes to the scope of work. From this point until the contractor completed work on the project, only four change orders were processed. This change procedure was established to streamline the process due to the number of design changes still

being made to the plant. DOE retained the right to review the technical changes for reasonableness and necessity. However, not all technical changes were reviewed and some were reviewed only after the work had already been completed.

Since the beginning of project construction, DOE has essentially relied on others, most with vested interests in the project, to assist in reviewing and approving change orders. As a result, DOE has little assurance that changes implemented during construction represented valid changes to the scope of work or were actually required under the original contract.

Construction contractor permitted to award a large number of subcontracts and to engage in unacceptable contracting practices

Petrochemical industry officials told us that the general construction contractor awarded an unusually large number of subcontracts for construction work at the H-Coal pilot plant. They added that in erecting a petrochemical plant the general construction contractor normally does most of the construction work using direct hire employees. They try to minimize subcontracting to keep construction costs down by eliminating any duplication of overhead expense and profit.

The H-Coal plant general construction contractor awarded 38 subcontracts valued at nearly \$15 million, or about 20 percent of the contract cost, for such work as erecting temporary and permanent buildings, building roadways, fabricating and installing piping, and installing instrumentation. In contrast, subcontracting at the EDS plant amounted to only \$4.3 million, or about 8 percent of the construction contract cost.

Our review of several of the 38 subcontracts showed that the construction contractor did not consistently follow generally accepted contracting practices in awarding and administering subcontracts. As a result, the cost of construction increased unnecessarily. Specifically, the general construction contractor

- did not maintain subcontract files which clearly and completely documented subcontract activities,
- disqualified bidders on weak or fabricated technicalities,

- awarded subcontracts valued in excess of in-house estimates without attempting to obtain more reasonable prices,
- awarded additional work to subcontractors at unreasonably high rates,
- awarded additional work costing thousands of dollars to subcontractors on a sole-source basis which was outside the scope of the subcontract,
- failed to develop a comprehensive list of potential bidders in all instances,
- terminated subcontractor services before completing work without equitably adjusting the subcontract price,
- awarded a nearly \$2 million subcontract on a noncompetitive basis, and
- failed to adequately supervise subcontractor field-work.

A primary reason for such performance is that the general construction contractor had little incentive to control costs under its cost reimbursable contract. Also, several subcontracts were awarded on a rush basis in an attempt to maintain or improve the construction schedule. Further, the contractor did not always employ sufficient or properly trained staff to administer subcontracts.

Timely audits of contractor cost not performed

An essential element of project management is timely audits of contractor cost. This becomes even more significant when contractors are operating under cost reimbursable contracts such as those awarded for the H-Coal plant. Regular audits of contractor cost provide opportunities for identifying and correcting problems such as those discussed in this chapter.

Our review of the H-Coal plant construction project revealed that DOE failed to conduct or otherwise provide for regular audits of its prime contracts. To date, only a few audits of limited scope were performed for DOE by DCAA. The vast majority of contractor activity has never been audited and, according to the onsite DCAA auditor, there is little hope that they will be in the future. In any case, the DCAA auditor believes it would be impractical to

conduct comprehensive audits of some contractor activity because records were so poorly maintained. Because regular audits of contract activity were not performed, DOE has failed to exercise an integral and important aspect of project cost control.

## CHAPTER 4

### DOE AND H-COAL CONTRACTORS INVOLVED IN POOR AND QUESTIONABLE CONSTRUCTION PRACTICES

The H-Coal pilot plant construction phase exceeded its baseline cost estimate by over \$54 million and its schedule by 16 months. Although not all of the increased cost and schedule slippage were controllable, some problems occurred because of poor judgment and lack of management and controls over the project by DOE and/or contractors. These included (1) starting construction before the completion of a sufficient amount of detailed design and without a viable construction schedule, (2) low labor productivity and the need to import craft labor, (3) improperly acquiring property and controlling it as received, (4) failure to minimize equipment cost, (5) inadequate quality control, (6) excessive project overhead, and (7) building beyond the needs of the pilot plant.

### CONSTRUCTION PROCEEDED IN AN UNORGANIZED MANNER

Essential to the start of large construction projects are a complete conceptual design, a well defined scope of work, a meaningful construction schedule, and a significant start on detailed construction designs. With these elements, project management has the necessary tools to provide proper direction to assure that construction progress is being made in an orderly and cost effective manner.

Our review of the EDS project showed that the first three elements cited and about 40 percent of the detail designs were complete before starting the plant construction. The joint preparation of the construction schedule by the engineering and construction contractors helped the project to proceed in an orderly fashion, thus minimizing cost growth and schedule slippage.

The H-Coal project, on the other hand, did not even have a complete conceptual design at the start of construction, thus, limiting the scope of work definition and the significance of the construction schedule. Therefore, construction work at the H-Coal project proceeded in an unorganized manner. Construction priorities were frequently changed which necessitated moving the work force, construction equipment, and in some cases materials stored at the construction site. This had a negative effect on worker productivity and caused delays in construction. Additionally,

the large number of change orders on this project resulting from design changes and errors further interrupted the momentum of construction.

The lack of realistic scheduling at the H-Coal project also resulted in the premature mobilization of the construction work force. Construction began in January 1977 and continued through the winter with minimal progress. Project officials told us that if the construction had been delayed until the spring of 1977, little or nothing would have been lost. In another instance, a painting subcontractor was brought on site in the fall and scheduled to paint through the winter months. This same contractor was then paid an additional \$27,000 to cease work and remobilize in the spring.

#### LOW LABOR PRODUCTIVITY AND THE NEED TO IMPORT CERTAIN CRAFTS

Both the EDS and H-Coal projects experienced problems with worker productivity. At the EDS project, low labor productivity was a factor during the latter stages of construction, especially among pipefitters, the major craft represented on the project. Low labor productivity was more serious, however, at the H-Coal project and remained as such throughout the entire construction phase. The following factors had a negative impact on productivity at the H-Coal project.

- Inadequate supervision of the labor force by construction management and field supervisors.
- Work rules were not strictly enforced.
- The construction site was cramped and often overcrowded.
- Workers were frequently reassigned to different work areas and supervisors.
- Excessive rework negatively affected worker attitudes.
- Construction management did not establish good relations with local trade and craft unions.

The above factors compounded to significantly affect worker productivity. Productivity remained below expectations even after Oak Ridge assumed responsibility for the project and construction management improved its supervision and enforced the work rules.

In addition, the H-Coal project suffered from an apparent inadequate supply of local area workers. The general construction contractor cited the lack of skilled workers (primarily pipefitters) in the local area as its reason for recruiting workers from all over the Eastern and Southern United States. Since these imported workers tend to be transient, a high turnover rate was experienced which required the contractor to provide constant training to new workers. Also, because the general construction contractor had to subcontract erection work to outside firms due to insufficient locally available labor skills, the added expense of importing outside labor was costly to the project.

PROPERTY ACQUISITIONS NOT CONDUCTED  
PROPERLY AND CONTROLS OVER PROPERTY LACKING

For large construction projects, coordination between procurement and construction functions and the control of materials and equipment are integral to the successful completion of the project. Proper coordination assures that needed equipment and materials are provided in a timely manner so as not to adversely affect the construction schedule or overload onsite storage facilities. Proper control protects equipment and materials from physical damage, misuse, and theft.

We reviewed equipment and materials coordination and control procedures and practices of both the EDS and H-Coal projects. The procedures and practices at the EDS project were adequate, but the H-Coal project had serious problems such as:

- poor coordination between procurement and construction functions,
- lack of control over equipment and materials,
- abusive handling of expensive materials, and
- spare parts not being ordered in a timely manner.

Because of these deficiencies in the management and handling of equipment and material, the construction schedule slipped and cost of the project increased.

Poor coordination existed between  
procurement and construction functions

For the H-Coal project, procurement of nearly all equipment components was the responsibility of the design

contractor. To successfully carry out this responsibility, the design contractor needed a construction schedule, developed and provided by the construction manager, to have equipment procured and delivered to meet construction needs.

Design contractor officials told us that, although construction schedules were provided, none were realistic. A meaningful schedule was not made available until procurements were nearly completed. Without a meaningful construction schedule, the design contractor had no alternative but to expedite the procurement and delivery of all equipment. This resulted in some equipment being delivered weeks and months before use, thus leading to overcrowding of storage facilities.

Lack of control over equipment and materials

Control of equipment and materials delivered to the site was the responsibility of the general construction contractor. We found that from the beginning of the H-Coal project, equipment and materials inventory control had been inadequate. Specific examples follow.

--Inventory records were not properly prepared at the time equipment and materials were received at the construction site. In some instances, inventory records were prepared based on quantities ordered rather than quantities received. In other cases, inventory records were never prepared.

--Inventory records were not properly maintained to reflect quantities of equipment and materials issued for construction use. This situation existed partially because of unrestricted access to the warehouse and because materials and equipment were stored outside in unsecured areas. Construction workers, therefore, had free access to large quantities of equipment and materials.

--Because inventory records were not always maintained to show storage locations, much time was lost searching for specific materials and equipment.

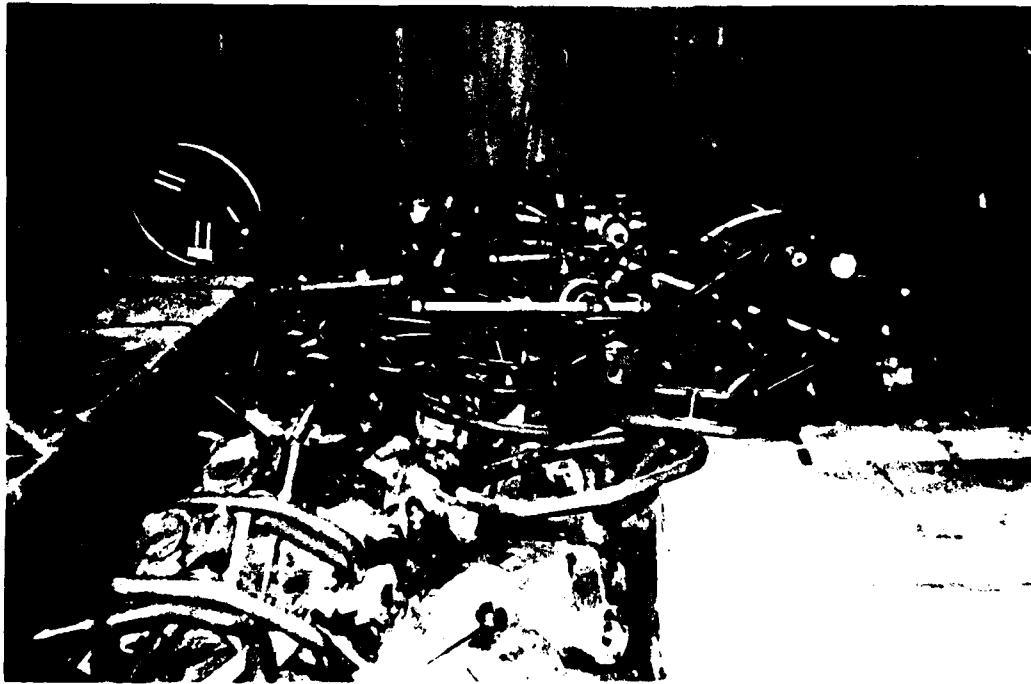
--Regular inventories were not conducted to reconcile materials and equipment on hand to inventory records.

Because controls were inadequate and inventory records were incomplete, there is no assurance that the quantity of materials purchased were ever received or used in construction.

Abusive handling of expensive equipment and materials

We were told by Government and project contractor personnel that the handling of equipment and materials at the H-Coal project was the worst they had ever experienced. Expensive equipment and materials were often left outside in an unprotected condition both before and after installation. For example:

- Expensive fittings were stored outside, many without protective coverings to guard mirrored surfaces from damage. Before many of these fittings could be used, they had to be repaired at a cost in excess of \$100,000; about \$75,000 of this was attributed to poor handling.
- About \$25,000 in damages occurred to large and expensive valves. The majority of damage was caused by poor handling of the valves in that they were stored outside, many without the protection of their shipping crates. They were further damaged when being loaded on a truck by contractor personnel for return to the manufacturer for repairs. The picture below depicts the way in which the valves were shipped.



VALVES BEING SHIPPED FOR REPAIR

--In another instance, electrical equipment was installed and then left unprotected. Much of this equipment was damaged beyond repair and had to be replaced.

Not only was abusive handling of material and equipment costly, but some involved project personnel were concerned these materials and equipment may cause failures during the operations phase.

Spare parts not ordered on time

The project design contractor was responsible for the procurement of major plant equipment and spare parts for the H-Coal project. Under normal circumstances, spare parts are procured at the same time original equipment for construction is purchased. The procurement of spare parts for the H-Coal project, however, was delayed because funds for design work and equipment procurement were comingled under one contract, and the design contractor used these funds to cover overruns in its cost for design work. As a result, about \$1.3 million was needed to complete the spare part procurements.

Overall project funding constraints precluded DOE from obligating additional funds so that spare parts could be procured in a timely manner. As a result, the following has occurred:

--Because certain spare valves were not available, it became necessary to substitute valves of an inferior quality during plant startup. These valves do not have the longevity of original equipment valves, which in turn, will require more frequent replacement at additional cost to the project.

--In another instance, it was necessary to replace a defective valve with one that was a different size, of a higher quality, and required modification. Not only was the cost of the valve higher than the valve being replaced, but the modification caused a 1-day delay in plant startup. A 1-day delay costs about \$40,000.

--The delay in purchasing spare equipment also resulted in escalated costs. In one case, repair tools for certain valves escalated from about \$20,000 in 1977 to over \$79,000 in 1980.

The last \$200,000 in spare parts were placed on order in March 1980, over a year after the design contractor's funds ran out. Even then, DOE had not obligated funds for the action and the contractor was forced to place orders based on a verbal commitment from DOE that its contract will be modified to cover these procurements. The delay in funding spare parts procurement has resulted in further escalation of costs and delayed delivery of critically needed parts.

#### CONSTRUCTION EQUIPMENT COSTS NOT MINIMIZED

DOE's policy is to purchase construction equipment instead of renting it from a third party where the accrued rental cost approximates the cost of ownership or the equipment costs less than \$1,000. On construction projects the size of EDS and H-Coal, equipment valued at several hundreds of thousands of dollars is used which falls under the equipment purchases policy discussed above.

Our review of the EDS project showed Exxon's policy on renting versus purchasing construction equipment is consistent with DOE's policy. At the H-Coal project, however, construction equipment which should have been purchased was rented. In comparing the rental cost to the purchase price of several items of common construction equipment at H-Coal, we found the average rental costs to be over 2-1/2 times the purchase price. Because of the large number of different items of equipment used, we did not attempt to compare all of them. The excess of rental costs over purchase price could, however, be a sizable portion of the \$800,000 rental costs.

The rental of construction equipment at the H-Coal project was also questionable because the general construction contractor rented this equipment from another subsidiary of its own parent company. Federal Procurement Regulations state that charges in the nature of rent between any division, subsidiary, or organization under a common control are allowable to the extent such charges do not exceed the normal cost of ownership. When we finished our review, DCAA was in the process of determining the total amount of excess rental charges.

#### INADEQUATE QUALITY CONTROL PROGRAM

Quality control is essential to construction projects, especially when they are of an experimental nature and operations are potentially dangerous to human safety like the H-Coal project. Yet, quality control and its oversight function quality assurance have been inadequate throughout the construction of the H-Coal project.

During the first 2 years of construction, quality control and quality assurance were practically nonexistent. In the same period, over 1/2 of the H-Coal project construction was completed. It was not until the last year of the construction phase that an organized quality control/quality assurance function was established. Even then, the effectiveness of the program was undermined because both functions were staffed and managed by the general construction contractor. Normally, quality assurance is under the supervision of the client, in this case DOE, or a third party.

The inadequacy of quality control at the H-Coal project resulted in serious construction defects and costly rework efforts, most related to field-erected piping. One such rework effort involved radiographic inspection of 4,342 welds, of which 1,115, or 26 percent needed repair. This rework effort cost over \$2.3 million. Additionally, it was necessary to replace about 1,100 feet of high pressure pipe because quality control failed to detect serious defects in the pipe before and during installation. The cost of this rework effort was nearly \$200,000. All rework costs related to poor craftsmanship or defective materials were borne by the project participants and the Government. Since the Government's participation is so large, it bore the major portion of the rework cost.

#### EXCESSIVE PROJECT OVERHEAD

The indirect cost accumulated by the general construction contractor for the H-Coal pilot plant was about \$8 million over normal expectations. About \$23 million, or 31 percent of the \$74 million charged by the general construction contractor was due to indirect costs. A DOE official told us that as a rule indirect costs in a construction project usually amount to about 20 percent of the total cost. In comparison, the EDS general construction contractor had indirect costs of about \$7.6 million, or 13 percent of total construction cost.

The H-Coal general construction contractor was originally a subcontractor for the erection of the plant. As a subcontractor, it had a full complement of management personnel including a construction manager, job engineer, field engineers, office manager, cost control supervisor, accountants, and so forth. In August 1978 the construction contractor agreed to a letter contract with DOE making it responsible for construction management. Its original estimate for construction management was about \$2.4 million. Subsequently, the cost of this construction management

effort increased to about \$4.3 million. DOE paid 100 percent of the cost of this additional management team.

After the reorganization of contractors, DOE paid for additional management personnel. The firm providing construction management before the reorganization retained about 20 personnel mainly by having a construction management coordination group. The general construction contractor added a construction management team composed of a maximum of 22 staff personnel. This established two separate groups at the site from the same parent company with one to provide oversight and direction over the other. One of the private participants questioned the need for both groups.

Despite the large investment in construction management, the project was plagued with construction-related problems, and completion objectives generally were not being met even under the new management team.

#### BUILDING BEYOND THE NEEDS OF THE PILOT PLANT

Support facilities at the H-Coal pilot plant site were built beyond the basic requirements of the project and constructed from materials far more elaborate than necessary. This occurred because a contractor had technical authority to change original building concepts and DOE failed to monitor the overall project. In particular, the administration building, worker change house, and guard monitoring station were constructed with materials suitable for a permanent plant. However, the H-Coal pilot plant program has a short-term life and even with extensions, the contract's final termination date is December 1985.

Original building designs for the H-Coal facilities were based on more austere building concepts, but were changed by the contractor with authority for technical direction. This same contractor's parent organization has a 99-year lease on the site. Because of contractual agreements, the Government may not be reimbursed for total costs of these facilities and materials when the project is completed.

Unlike the H-Coal project, more austerity was practiced on the EDS project. Because of the manner in which construction contractors kept costs, we could not always make direct dollar comparisons for facilities at these two projects. However, the pictures included in this chapter show the different building concepts. It is apparent that the cheaper and more austere options were chosen at the EDS project.

### Administration building

The administration facility built at the H-Coal pilot plant cost nearly \$700,000 or twice that of its comparable EDS facility. Each administration facility is about the same size at 15,000 square feet and provides working space for about 70 people.

The difference between the two facilities is easily seen in the pictures on page 37. At the EDS pilot plant a prefabricated metal building of simple design with no windows or other special features was constructed at a cost of about \$370,000. The H-Coal facility is a brick and block structure with double insulated reflective glass windows, a special heavy duty roof, and copper plumbing. Its final cost was \$699,947.

The original concept and preliminary designs for the H-Coal administration building specified a two-story prefabricated unit. No cost estimate was prepared on the prefabricated unit. The contractor with technical direction over the design of civil structures elected to have the administration building along with others such as the worker change house redesigned. There was considerable deliberation over alternative structures between DOE, the architect-engineer, and the technical direction contractor. DOE approved the more elaborate design, but expressed their disagreement with the final concept of administration building as shown in the below extract, but this occurred after the contract had been executed.

--The original concept of the building was a functional prefabricated metal structure, free of all encumbrances, designed with the philosophy that the building has no greater life than the project, approximately 5 years.

--It appears that this design criteria was exceeded in several areas, namely the ceiling, windows, and shell materials.

### Worker change house

The worker change house for both the H-Coal and EDS pilot plants followed the same building concepts as those used on the administration facilities. The H-Coal worker change house was originally designed to be a prefabricated unit, but the design philosophy again was altered by the contractor with technical direction authority. As a result, a brick and block structure was constructed. The worker

change house at the EDS plant is in a large general purpose building which is a prefabricated unit. The difference in building concepts is displayed by the pictures on page 38.

The H-Coal worker change house is a two-story 6,000 square foot brick and block building, including a guard monitoring station discussed below, which cost about \$535,000. Special features besides the brick and block outer shell include chrome plated shower heads, copper piping, and a precast concrete roof deck.

In contrast, EDS provided for most of its worker change facilities as part of the 21,500 square foot general purpose building. This is a metal structure which also contains a small laboratory, warehouse, lunch room, and office space for the pilot plant. The space provided for the worker change house is about a fifth of the building. The cost of the entire complex was \$608,000, which was more than the H-Coal change house complex, but not so when considering the other services the building offers to the pilot plant.

#### Guard monitoring station

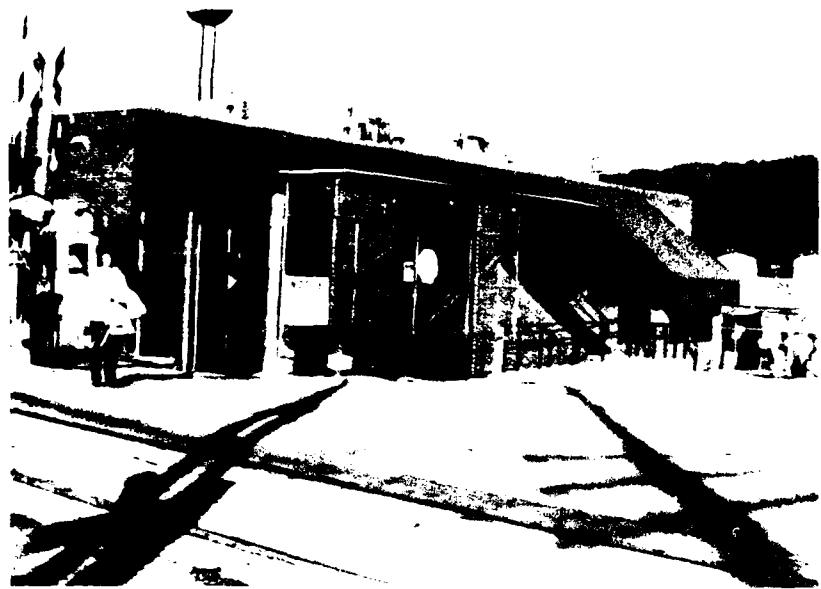
The guard monitoring station at the main entrance to the H-Coal pilot plant is another example of over building. The H-Coal guard monitoring station is part of the brick and block worker change house. It is located on the front side of the change house and its distinguishable feature in the picture on page 39 is the large observation window. In contrast, EDS has a temporary and less elaborate building for its monitoring station. Although costs were not distinguishable for these guard monitoring stations, the pictures of the facilities show the contrast in building concepts.



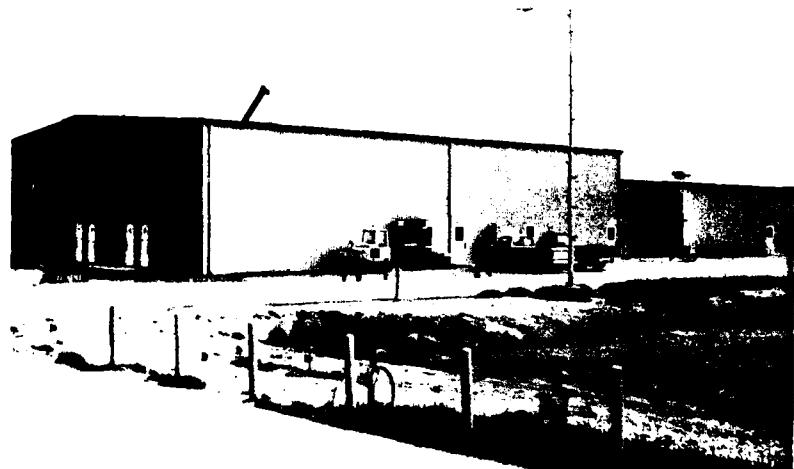
H-COAL ADMINISTRATIVE BUILDING CATLETSBURG, KENTUCKY  
COST \$699,947



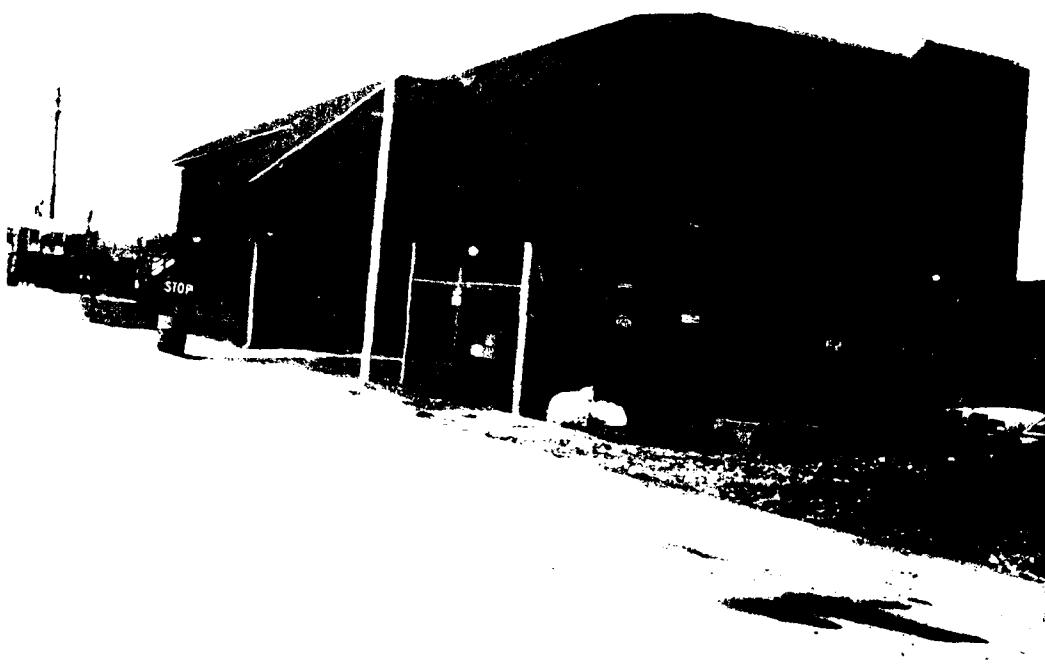
EDS ADMINISTRATIVE FACILITY BAYTOWN, TEXAS COST \$369,911



H-COAL WORKER CHANGE HOUSE



EDS GENERAL PURPOSE BUILDING INCLUDES THE WORKER  
CHANGE HOUSE



H-COAL GUARD MONITORING STATION



EDS GUARD MONITORING STATION

## CHAPTER 5

### DOE PLANS FOR SRC DEMONSTRATION PLANTS

Demonstration plants for SRC-I and SRC-II are presently under detailed design and are scheduled for a construction start in March 1981. Each plant will process about 6,000 tons of coal a day and represent a scale up from small 6 and 50 ton-a-day SRC pilot plants to a commercial size module. This type of scale up is much greater than the size development approach taken on H-Coal and EDS and therefore represents a larger risk. Two separate facilities will be constructed, one near Newman, Kentucky (SRC-I), and the other at Morgantown, West Virginia (SRC-II).

The initial estimate given for each SRC demonstration plant was \$685 million. After preliminary design, the costs to design, construct, and operate were reestimated by DOE contractors to be almost \$1.9 billion for SRC-I and almost \$1.4 billion for SRC-II. These estimates did not contain any provision for contingencies, escalation, or potential product revenues. With contingencies and escalation added, the DOE contractors estimated the costs at \$3.1 billion for SRC-I and \$2.7 billion for SRC-II. Potential product revenues which would offset a portion of the cost were not included in these estimates.

Later estimates prepared by DOE and contractors show each SRC project to cost \$1.4 billion when revenues from product sales are included. However, these latest estimates still exclude contingencies and escalation during the 5-year operations phase. We believe escalation and contingency estimates should be included in the project costs since complete cost estimates are critical to future decisions on the two plants.

### DOE APPLICATION OF LESSONS LEARNED ON OTHER LIQUEFACTION PROJECTS

The cost impact could be enormous if the problems associated with the H-Coal project are repeated on either of these large scale demonstration plants. DOE officials told us they have taken steps in their planning for these two projects to avoid past pitfalls. They said this includes, using a different project management structure, assigning both projects to a DOE field office experienced in construction, staffing the projects with DOE and support contractor personnel, and relaxing the schedule to provide additional time for detailed design before the start of construction.

### Project management structure

DOE intends to have straight-line management on each SRC project in contrast to H-Coal and EDS committee structures. DOE will head each project, but permit contractors to carry out their assigned roles. DOE will also reserve the right to direct contractors when they feel it is appropriate.

One of the drawbacks to this management structure is neither of the selected principal contractors for SRC-I and SRC-II have substantial Government contracting experience nor are they construction oriented. DOE intends to rectify this situation by having construction management firms under these principal contractors. The construction management firms would direct and monitor the efforts of various subcontractors.

DOE has assigned these projects to its Oak Ridge field office for overall day-to-day project management and contract administration. Many of the same personnel who inherited the H-Coal project when it was totally in disarray will have these projects from their inception. Unlike H-Coal, which initially started with only 1 DOE site representative and then built up after the project was out of control, these 2 SRC projects are to be staffed with a total of 30 to 35 personnel including about 20 personnel from a support contractor experienced in construction who will serve as the technical advisor to the DOE site personnel.

### Project schedules

DOE has directed some modifications to contractor prepared schedules for the two planned SRC demonstration projects because of experience in the H-Coal and EDS pilot plant projects. Specifically, the following actions have been taken:

- A detailed design was expanded from a 14- to 39-month effort.
- A detailed design precedes construction by about 17 rather than 12 months in the old schedule.
- A construction start delayed until March 1981 to allow additional time for detailed design.

These changes result in revisions to program phases as shown on the next page.

<u>Phase</u>	<u>Old schedule</u>	<u>Revised schedule</u>
Detailed design	Sept. 1979 to Nov. 1980	Oct. 1979 to Jan. 1983
Construction	Sept. 1980 to Dec. 1983	Mar. 1981 to July 1984
Operations	Jan. 1984	Oct. 1984

Even the above revised schedule for SRC plants, prepared by contractors, is considered by DOE to be optimistic. Within the old and revised schedules, the contractors have allowed about 40 months for construction. EDS and H-Coal, which are much smaller projects, actually took 26 and 36 months to construct, respectively. Additionally, the detailed design phase for each SRC plant will run concurrently with construction for about 22 months from March 1981 to January 1983.

#### Cost estimate

The substantial increase in cost estimates for these SRC projects is based on additional knowledge acquired through more design work. The initial estimate of \$685 million each was based on 1975 dollars and done before preliminary design. Contractors worked on the assumptions that these two SRC plants were like a refinery but scaled them down to about 1/5 the size which resulted in a 6,000-ton-a-day module. The DOE contractor estimates (after preliminary design) covering detailed design, construction, and operations were about \$1.9 billion for SRC-I and about \$1.4 billion for SRC-II and were prepared by contractors at a time when the Government funding equaled about 1 percent of the above predicted final costs. DOE officials told us that they will have greater confidence in such estimates when funding equals about 5 percent of the predicted final costs which is expected to occur in fiscal year 1981.

The above contractors' estimates did not contain provision for contingencies, escalation, or potential product revenues. The latest DOE and contractor estimates are \$1.4 billion for each SRC project. These latest estimates account for product revenues but still do not contain any contingencies or escalation for the 5-year operations phase. These projected figures are important principally as a key factor in deciding that the technology warrants support, along with other factors, such as its economics, environmental impacts, and chances of commercial success, both individually and in comparison with competing technologies.

The SRC-II project has acquired the largest investment from private sponsors. On both the SRC-I and SRC-II projects, the U.S. private sponsors have agreed to invest about \$100 million which represents about 7 percent of the latest

DOE and contractor estimates (based on \$1.4 billion for each SRC project). However, the SRC-II project has attracted considerable interest by the Federal Republic of Germany and Japan, each of whom is prepared to contribute 25 percent of the project costs. Their interest is based on their needing liquid rather than solid fuels.

We believe DOE should be concerned about the small percentage of investment on the part of U.S. private sponsors for both SRC projects. In this country, many of the electric utility companies burn coal and would be expected to be interested in a relatively clean burning SRC-I product. However, new Federal clean air standards for sulfur and nitrogen dioxide require strict percentage removal of these pollutants for all new and retrofitted generating units. DOE officials told us they suspect the relatively low interest in SRC-I among U.S. utilities is related to the overall uncertainty about air standards. We noted, however, that a combustion test of the SRC-I solid product in 1977 demonstrated its capability to meet then current emission standards for sulfur and nitrogen oxides.

#### NEED FOR TWO SRC DEMONSTRATION PLANTS

The two SRC plants employ similar but distinct applications of the same technology. Basically, SRC-II can produce a different array of products than SRC-I. The majority of the products from both SRC processes would be used by electric utility companies. Generally, the northeastern utilities would be the market for the liquid SRC-II and the southeastern utilities for the solid SRC-I product.

The rationale of building two SRC plants has been questioned in the past by the Office of Management and Budget apparently because of austerity, since each project was estimated to cost \$700 million. The Office of Management and Budget recommended competition between the two processes with one proceeding into the demonstration phase. The Carter Administration originally went along with this concept. DOE, however, stood behind the two projects at two separate sites; the administration relented by restoring both and proposing to pay for one with proceeds from a windfall profit tax. In retrospect, perhaps the Office of Management and Budget's idea of competition should have been applied to all four liquid processes--H-Coal, EDS, and SRC-I and -II.

PROTECTING GOVERNMENT'S INVESTMENT  
IN FULL-SCALE MODULES NEEDS SPECIAL ATTENTION

Both the H-Coal and EDS developers fully expect their pilot plants sized between 200 and 600 tons a day to provide the data needed to make commercial decisions. Their reactors are sized in between existing laboratory units and the type of units required for a commercial plant. Both developers told us their approach represented normal progression in process development toward commercialization.

In contrast, the SRC processes have been tested in very small pilot plants. SRC-I has been tested on 6- and 50-ton-a-day units. The 50-ton-a-day unit was later converted to SRC-II, but at a capacity of about 30 tons a day. We were told by one of the liquefaction developers that a much greater risk is involved in moving from these small-scale pilot plants to a demonstration effort, especially with commercial-scaled reactors, than that taken on EDS and H-Coal. This, however, assumes that sharing of information and experience from the larger H-Coal and EDS pilot plants does not take place or will have no benefit in reducing scale-up risks of SRC development plants. In our earlier report, 1/ DOE officials stated, and private sector officials agreed, that operation of commercial-scale SRC demonstration plants, in combination with the experience gained from operation of the pilot plants, might enable construction of commercial EDS and H-Coal plants without demonstration plants for these two processes.

If both the H-Coal and EDS developers believe their pilot plants costing about \$300 million each are sufficient to make commercial decisions, why is DOE investing in these larger SRC demonstration facilities? DOE officials replied that the SRC-I and SRC-II commercial modules will remove any doubt about the value of all liquefaction processes and each SRC site can be expanded with additional modules to form a productive commercial facility. Our earlier report stated that since the basic technology for all four processes is similar, sharing of information and experience could benefit development of each of the processes. It also indicated that the financial community is concerned about scale-up and may not invest capital in commercial plants unless the processes are operated at a size large enough to demonstrate commercial operability and reliability.

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1/ "Liquefying Coal for Future Energy Needs," EMD-80-81,  
Aug. 12, 1980.

On the basis of enormous investments required for these two projects and coupled with some uncertainties about the large scale up, DOE needs to proceed with some degree of caution to assure the project is adequately designed before beginning construction, thus avoiding construction quality problems. A repeat of the problems experienced on the H-Coal project would have a devasting impact.

## CHAPTER 6

### CONCLUSIONS AND RECOMMENDATIONS

#### CONCLUSIONS

Our review of the H-Coal and EDS pilot plant projects revealed inadequacies in DOE's contracting practices and a failure by DOE to properly plan, manage, and monitor the projects. As a result, excessive cost growth, quality problems, and schedule slippages occurred on the H-Coal project. Only sound management practices on the part of Exxon and a more balanced cost sharing agreement prevented such serious problems from occurring on the EDS project. In view of the large expenditures planned for additional demonstration projects, it is essential that DOE improve its contracting and management practices to assure the Government's interests are properly protected.

Specifically, we have concluded that:

- The initial Government-industry H-Coal agreements regarding the level of investment by private sponsors and the ceilings imposed on sharing in cost growth were imbalanced. Larger investments by private sponsors and responsibility in sharing cost growth make all parties more cost conscious. EDS with its 50/50 cost sharing was a prime example of ideal Government-industry financial responsibility and shared risk. As a result, the EDS project had more adequate controls over cost.
- DOE started the H-Coal project prematurely before sufficiently detailed designs were available. This action was taken as a reaction to the "energy crisis" and despite warnings of the plant designer. The project was not adequately planned and key management functions such as a construction schedule, materials handling, inventory systems, and a quality control program were nonexistent for most of the construction period.
- DOE staffing was inadequate at both projects to effectively monitor progress and contribute to timely decisions. This was especially so during the construction phase and as a result, at the H-Coal project many poor and questionable construction practices occurred which contributed heavily to the escalation in both cost and schedule.

--DOE's H-Coal contracts were poorly written because they did not define the scope of work other than in general terms and failed to fully protect the Government's investment.

--DOE plans for the two large demonstration plants need careful review and attention in light of escalating cost and the risks involved in scaling up to the 6,000-ton-a-day facilities. The projected costs together with such others as economics, environmental considerations, and chances of commercial success are key factors in deciding if both processes warrant support in view of competing technologies.

#### RECOMMENDATIONS TO THE SECRETARY OF DOE

To improve the monitoring and control over future coal liquefaction and other energy projects, we recommend that the Secretary of DOE:

--Assure that projects are properly planned and designed sufficiently before they start to avoid disruptions and to hold design changes to a minimum.

--Provide adequate DOE support staff to monitor the various phases of its projects and to assure that management tasks such as property control, inventories, subcontracting, and so forth, assigned to private industry are done within regulations and with adequate management controls.

--Establish a format for existing monthly project reports (prepared by contractors) to provide data needed by DOE to effectively monitor the projects.

--Encourage the use of fixed-price contracts when it becomes practicable for the contractors to define their remaining efforts and quantities required.

To enhance the prospects for successful future commercialization and lessen the Government's financial burden, the Secretary of DOE should obtain a more equitable percentage of investment from private sponsors for all phases of the energy projects to assure they share in the risks and fully apply their expertise towards assuring sound management, including adequate controls over cost and schedule.

The Secretary of DOE should also provide to the Congress an assessment of the effect that the escalating costs of the SRC plants and the risks involved in scaling up to the

6,000-ton-a-day facilities, along with other relevant factors, will have on the feasibility and affordability of both projects and the ability of DOE to reach its program objectives.



**Department of Energy  
Washington, D.C. 20585**

SEP 15 1980

Mr. J. Dexter Peach  
Energy and Minerals Division  
U.S. General Accounting Office  
Washington, D.C. 20548

Dear Mr. Peach:

The Department of Energy has completed a review and analysis on the Draft of a Proposed General Accounting Office Report entitled "DOE's Direct Coal Liquefaction Program: Need for Improvement in Management and Controls" dated August 1980.

The Major Fossil Energy synthetic fuels development and demonstration programs are conducted under the unique cost sharing contractual authorities granted in the Federal Nonnuclear Energy Research and Development Act of 1974. In this activity, the Department is not engaged in typical cost plus contracts common in normal, mature development programs for which the government is the customer or ultimate user. The Department has entered into cost sharing contracts with the private sector which includes significant foreign participation. As such, the normal government management techniques, programmatic controls and staffing applicable to Department of Defense, National Aeronautics and Space Administration and similar projects must be altered and adapted to each specific situation.

The Department has had difficulties in the past with projects including H-coal as stated in the referenced report. These experiences provide invaluable data for development of improved management and contracting practices for the new synthetic fuel demonstration projects. The Advisory Panel Report on Synthetic Fuels to the House Committee on Science and Technology dated January 31, 1980 addressed improvements that are needed in the Department's synthetic fuels demonstration program. The Panel concluded that the development and demonstration efforts have suffered from cost overruns, project delays, improper management and too much federal involvement. The Panel recommended bringing industry in at all levels, giving them the technical and management responsibility for all projects and eliminating projects not of interest to the private sector. It further recommended that the Department's demonstration program be designed such that the companies who are going to own and operate the full-scale plants acquire the direct experience with the management and operation of the projects--and without the type of government controls and second guessing, likely to lead to delays and increased costs. The Panel Report appears to

-2-

be in conflict with the basic issue of the referenced report and the experiences to date on the projects. The Department's current approach on the new synthetic fuel demonstration projects is to capitalize on experiences to date, utilize existing managements structure, policies and directives on program/project management control and reporting, decentralize project management and contracting officers' responsibilities to existing field structures and adapt to the unique relationship with the private sector including foreign participants.

The problems addressed in the referenced report on the H-coal project are not new to the Department. The need for improved practices has been acknowledged since 1978. The problems were addressed in project manager's assessment reports, independent project evaluation report in January 1978 and in the Department's Inspector General Report of May 1979. Furthermore, during the last three fiscal budget cycles, the Department has provided detailed responses to specific questions from the House and Senate Subcommittees on the entire synthetic fuels program including the H-coal project.

The problems identified in the report with the H-coal project were addressed and corrected over a year ago by responsible DOE managers and discussed with General Accounting Office personnel. The experiences with past projects have been very useful and will definitely provide a basis for improving management practices for future cost shared synthetic fuel projects sponsored by the private sector. We believe that a more accurate description of the coal liquefaction project management situation could be obtained by fully characterizing the actions taken by the Department in these problem areas. The report accurately identifies and describes the problem areas and is quite useful. However, the report could be misleading because of the failure to consider the actions to mitigate many of the noted problems.

The report reflects information provided by Department personnel in a serious effort to cooperate and provide factual information. It is unfortunate that the information that was provided was not understood. Thus the report contains a large number of specific statements and comments which are in error or subject to misinterpretation. Detailed comments on the report are available for further discussions if so needed.

Recently members of your staff met with Fossil Energy to discuss a draft of another proposed General Accounting Office Report entitled "Problems of DOE's Solvent Refined Coal Liquefaction Program" dated July 1980. It was a talking paper for discussion purpose only. There was a considerable amount of discussion and written comments/documentation provided which is directly applicable to the referenced report.

Sincerely,



P. Marshall Ryan  
Acting Controller

GAO NOTES

In its response, DOE draws upon a recommendation of the House Science and Technology Committee Advisory Panel on Synthetic Fuels that private industry should be brought in at all levels of projects giving them technical and management responsibility and Federal involvement in daily decisions should be lessened. In this report, we did not recommend excluding private industry from managing synthetic fuel projects and reported on the relative success of the EDS project which had far less Government controls than the H-Coal project. We believe DOE, as the major project sponsor and overall monitor, however, must assure itself that synthetic fuel contractors manage these projects within applicable regulations and that adequate management controls and contract practices are in place to control cost and meet schedule objectives. We further agree with the Advisory Panel's recommendation that DOE require significant private capital be put to use to obtain private commitment to a project's success. The Advisory Panel also recommended eliminating projects of little interest to the private sector.

We recognized that DOE and its construction consultants identified many of the H-Coal project problems (see pp. 9 to 11) and exerted pressure on contractors to complete their efforts within new cost and schedule milestones. This may have prevented even further cost growth and schedule slippages, but at the time these actions occurred the real financial and schedule consequences had already affected the project.

In its September 15, 1980, letter, DOE also stated the report contained a large number of specific statements and comments which were in error or subject to misinterpretation. These matters were subsequently resolved as discussed in the following DOE letter to us dated November 9, 1980.



**Department of Energy  
Washington, D.C. 20585**

NOV 9 1980

Mr. J. Dexter Peach  
Energy and Minerals Division  
U. S. General Accounting Office  
Washington, D.C. 20548

Dear Mr. Peach:

Reference is made to the Department of Energy letter dated September 15, 1980, to you, relative to a draft of a proposed General Accounting Office report entitled "DOE's Direct Coal Liquefaction Program: Need for Improvement in Management and Controls."

Detailed discussions were held on October 6-7, 1980, between Mr. Demidovich of the Procurement and Systems Acquisition Division of GAO and Mr. Bauer of the Fossil Energy Office of DOE. The purpose of the discussion was to review detailed comments that were available on the report as well as our comment that the report was possibly misleading or contained errors. It is my understanding that these individuals have reached agreement and resolved all potentially misleading or erroneous statements. In this situation, we were provided additional information which corrected our early position and the General Accounting Office was provided clarification of points for possible inclusion in subject report.

It should be noted that the Department recently completed an intense effort to describe the implementation of new Department of Energy project directives and management of Fossil Energy major projects. The size, scope and visibility of these projects require a comprehensive and effective management system to ensure that the planning and execution of the various projects, many of which are well underway, comply with technical, schedule, cost performance and environmental objectives.

The management system utilizes the existing headquarters and field organizations, supports the policy of project management to the field, conforms with the Department management responsibilities procedures, and recognizes the partnership with the private sector. The system also makes maximum utilization of "lessons learned" on past and present projects.

Sincerely,

 A handwritten signature in black ink, appearing to read "P. Marshall Ryan".
 

P. Marshall Ryan  
Controller

cc: W. H. Sheley, Jr.

APPENDIX II

APPENDIX II

GAO NOTES

The contents of this report were discussed with DOE headquarters and Oak Ridge officials and their collective comments were considered in light of the data and evidence gathered in our audit. We concur with the DOE letter that resolution was reached on points considered in error or subject to misinterpretation.

We also recognize DOE's efforts to improve its overall management of major energy projects. As recommended in this report and stated in the DOE letter, DOE needs to make maximum use of the "lessons learned" on the H-Coal and EDS project and apply them to future liquefaction as well as other energy projects.

## APPENDIX III

## APPENDIX III



ASHLAND SYNTHETIC FUELS, INC. • POST OFFICE BOX 391 • ASHLAND, KENTUCKY 41101 • PHONE (606) 329-3333

CHARLES D. HOERTZ  
President  
(606) 329-3399

September 8, 1980

Letter No.: AO-1552  
Contract: DE-AC05-76ET10143  
Project: H-Coal Pilot Plant  
Subject: Draft Report: "DOE's  
Direct Coal Liquefaction  
Program"

Mr. W. H. Sheley, Jr.  
U. S. General Accounting Office  
Procurement and Systems Acquisition Division  
Washington, D. C. 20548

Dear Mr. Sheley:

We appreciate very much the opportunity to review the draft report, "DOE's Direct Coal Liquefaction Program: Need for Improvement in Management and Contracting." We believe the report, for the most part, accurately reflects the status of the H-Coal Project from inception through the date of your review. However, we do have the following comments.

1. Approximately 25% of the \$117 million cost increase in the H-Coal Project is a direct result of added scope of work, which was not included in the original baseline. The Antisolvent Deashing Unit (Area 500), the Waste Oil Recovery Unit (Area 600), the Nitrogen System, the Propane System, and the attendant operations and maintenance costs are examples of major items added after the initial baseline was established.
2. Essentially all of the remaining 75% of the \$117 million can be attributed to the decision to proceed with construction of the Plant when only 20-25% of the engineering design work was completed. This limited design, which was used to make the original capital and operating cost estimates, was far short of that needed for definitive projections. The result was a poor baseline estimate; severely restricted use of fixed price, lump sum subcontracts; numerous changes to and interruptions of the work; and, limited effectiveness of the planning and scheduling activities associated with such a complex project.

APPENDIX III

APPENDIX III

Mr. W. H. Sheley, Jr.  
Page 2  
September 8, 1980

Finally, any comparison between project costs for EDS and H-Coal should take into account the impact of climatic conditions. After commitment of construction on the H-Coal pilot plant, the Ashland, Kentucky, area experienced three of the hardest winters known. Completion of the plant was probably delayed six months because of this severe weather, causing significant cost increases. Such elements were not a factor with the EDS plant and would account for much of the difference between the two plants noted in the report.

3. Rather than proceed with the prefabricated steel type building contained in the conceptual design, ASFI and the A&E subcontractor recommended brick and block construction over the prefabricated types for the Administration Building because of lower construction, operating and maintenance costs. DOE approved this design after making some minor cost-saving revisions. The actual cost of the Administration Building was approximately \$47 per square foot as compared to approximately \$60 per square foot for similar construction in the area.

At DOE's request, the A&E subcontractor also made a cost comparison of alternative types of construction for the Change and Guard House. Following a review of this comparison, DOE directed that brick and block construction be used. The cost of the Change and Guard House was approximately \$73 per square foot as compared to approximately \$80-\$125 per square foot for similar buildings in the area.

As for your comparison between the EDS and H-Coal buildings, we believe that an examination of the construction practices in the two areas would identify differences in functional requirements, materials availability, building trade methods, etc., would explain the variation.

4. While we have noted some reference in your report to the change in DOE management on the H-Coal Project, it does not properly reflect the essential role the new project team from DOE's Oak Ridge office had in bringing stability to the program. They have provided the professional input from DOE that is necessary on a project of this magnitude, but was almost nonexistent prior to their involvement.

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Mr. W. H. Sheley, Jr.  
Page 3  
September 8, 1980

Again, thank you for the opportunity to review the draft report. We are prepared to discuss this report with you or to provide additional information if required. Please furnish us with a copy of the final report.

Sincerely,

*CD Hoertz*  
C. D. Hoertz

CDH:sg

GAO NOTES

We concur with the Ashland Synthetic Fuels, Inc., statement that the H-Coal project's cost baseline of \$178.8 million was a poor estimate and not inclusive of the entire scope of work including two sections of the plant. We also concur with the Ashland position that more fixed price lump-sum subcontracts should have been used on this project, and we believe it should have been accompanied with a properly managed change order system to allow for legitimate increases in the scope of work due to design and other changes.

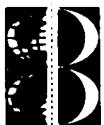
On the buildings constructed on the H-Coal site, specifically the administration, and worker change, and guard house shown on pages 37 to 39 in this report, we believe Ashland should never have put itself in this position. With technical direction authority, it made changes to the original building concepts, and its only support for the lower cost estimates of this chosen form of construction was done by an architect-engineering firm hired by Ashland. DOE did express its disagreement with the building concept for the administration building (see p. 35.) DOE's procurement group recommended that Ashland only be reimbursed for the proper price of buildings that should have been built. An independent estimate considering all factors including those mentioned in the Ashland letter should have been done when building concepts were changed. DOE's construction consultants would have been able to assess the building concept issue, but they were not brought on as construction monitors until after this action was completed.

We agree with the Ashland position that DOE Oak Ridge did add stability to the program and moved it toward construction completion (inclusion of this statement recognizing Oak Ridge's role is on p. 16 of the report.)

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**BADGER ENERGY, INC.**

SUBSIDIARY OF THE BADGER COMPANY INC

*Designers • Engineers • Constructors*

ONE BROADWAY, CAMBRIDGE, MASSACHUSETTS 02142

25 September 1980

United States General Accounting Office  
Procurement and Systems Acquisition Division  
Washington, D. C. 20548

Attention: Mr. Joseph Bohan  
Deputy Associate Director

Subject: Draft Report Entitled Department of Energy's  
Direct Coal Liquefaction Program  
"Need for Improvement in Management and Control"

Reference: GAO Letter by W. H. Shelly, Jr.  
Dated 14 August 1980

Gentlemen:

We wish to express our appreciation for the opportunity of responding to the subject U. S. General Accounting Office (GAO) draft report. The content of our response is included as an attachment to this letter.

This response is directed at those GAO comments contained in the draft report which we believe need clarification. It pertains strictly to Badger's involvement in those areas covered by the report.

Badger Plants, Inc., a wholly-owned subsidiary of The Badger Company, Inc., performed the erection and was the successor construction manager for the H-Coal Pilot Plant at Catlettsburg, Kentucky. Badger Energy, Inc., also a wholly-owned subsidiary of The Badger Company, Inc., is the successor subsidiary to Badger Plants, Inc. This response, therefore, is made by Badger Energy, Inc.

A Raytheon Company

OFFICES IN TAMPA AND HOUSTON  
AFFILIATES IN THE HAGUE, LONDON, PARIS, TAIPEI, TOKYO AND OTHER PRINCIPAL CITIES OF THE WORLD

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**BADGER ENERGY, INC.**

U. S. General Accounting Office  
Procurement and Systems Acquisition Division  
Attn: Mr. Joseph Bohan  
25 September 1980  
page two

We hope this will be of assistance in finalizing the draft report. Thank you again for this opportunity.

Sincerely yours,

BADGER ENERGY, INC.

*G. T. Flint*

G. T. Flint  
President

GTF/pal

Attachment

## APPENDIX IV

## APPENDIX IV

BADGER ENERGY, INC.

Attachment to  
BEI Letter dated  
September 25, 1980

### RESPONSE BY BADGER ENERGY, INC.

TO  
GAO DRAFT REPORT  
ENTITLED

DOE'S DIRECT COAL LIQUEFACTION PROGRAM  
"NEED FOR IMPROVEMENT IN MANAGEMENT AND CONTROL"

The information contained herein represents the response of Badger Energy, Inc. (BEI) to the above titled draft report prepared by the U. S. Government Accounting Office (GAO), which was forwarded to Badger for comment by GAO covering letter dated August 19, 1980, signed by Mr. W. H. Shelly, Jr.

Each Badger response listed below is preceded by paraphrases of the appropriate GAO comment and follows the sequence of the draft report by page number.

#### I. Badger Plants, Inc. -

##### Contractual Participation in H-Coal Project

- A. Badger Plants, Inc. (BPI) was the successful bidder in a highly-competitive solicitation for the erection of the H-Coal Pilot Plant.
- B. BPI and Ashland Synthetic Fuels, Inc. (ASFI) reached mutual agreement through negotiations, and contract HC-10 was executed by the parties on November 8, 1976.
- C. BPI was authorized by DOE to perform H-Coal Construction Management by the execution on August 10, 1978, of Letter Contract Modification M001 to DOE Contract No. ET-78-C-01-324. Said DOE contract number was assigned to ASFI subcontract HC-10, which had been previously transferred to the Government on July 12, 1978.
- D. To avoid possible confusion when referring to the project constructor and construction manager, it is requested that GAO refer to BPI's project roles in the following manner:

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Erection Contractor - For the execution of areas 100, 200, 400, 500 and 600 for the period November 8, 1976, through construction completion.

Successor Construction Manager - For the period July 12, 1978, through construction completion.

II. GAO Comments/Badger Responses

1. Progress Measurement

GAO Comment: An irregular measuring system was used to assess progress on a manhours per ton basis. (page 15)

Response: The standard Badger practice is to measure its progress in manhours against the appropriate construction unit of measure. This unit of construction measure could be manhours per ton, as stated, but also manhours per linear feet, square feet, cubic yard or whatever construction unit measure is appropriate.

Badger has employed this progress measurement system for many years.

2. Subcontracts and Subcontracting Practices

GAO Comment: The erection contractor was allowed to (1) award an excessive number of contracts, and (2) engage in unacceptable subcontracting practices. (pages 28 (1), (2) and 34 (1) )

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Response: (1) The scope of BPI's subcontracting activities was set forth in its competitive proposal to ASFI. This scope reflects normal Badger subcontracting levels for specialized construction work. This level of Badger construction project subcontracting is 20 to 25 percent, which represents road building, electrical installation and insulation installation, to name a few. This level of subcontracting is normal industry practice, and therefore, the charge "excessive number of subcontracts" should not be made.

(2) BPI's subcontracting practices were monitored throughout the project erection period by ASFI, DOE and DCAA and were found to be acceptable.

### 3. Inconsistency in Subcontracting Practices

GAO Comment; The erection contractor did not consistently follow generally accepted contracting practices, and the cost of construction increased unnecessarily. (pages 34 and 35)

Response: We do not believe these comments to be valid. All of the 38 subcontracts were reviewed and approved by either ASFI (24) or DOE (14). Changes notwithstanding, any significant construction cost increases should not be attributed to contracting practices.

It is unclear as to how the listing of questionable subcontracting practices, as shown on page 35, could have been determined, as the facts do not support the conclusions, in those cases which have been documented. Significantly:

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- Subcontract file data was adequately maintained, although some subcontract files may not have contained technical or cost data that was filed in other project areas.
- Extra work was awarded to existing, onsite contractors when schedule considerations were paramount to the work.
- Any terminated subcontractor is believed to have been equitably compensated for work performed, and consideration was also made in the area of price reduction.
- A nearly two-million-dollar subcontract was not made on a noncompetitive basis. Five bidders were solicited for this effort, which was for pipe erection. Four no bids were received, and the subcontract was awarded to the single qualified bidder.

### 4. Construction Management Change Order Approval

GAO Comment: Almost two years after construction began, Construction Management Contractor's change order authority was discontinued (in December 1978) because the contractor's procurement system was inadequate. (page 32)

Response: We find this comment difficult to understand for the following reasons:

- In December 1978, BPI had been the Construction Manager Contractor for less than six months.

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- The DCAS Procurement System Review was conducted during January 8 - 19, 1979.
- The DCAS report of this review was issued in May 1979.
- The DCAS report stated that, in general, the Badger procurement system was not in compliance with U. S. Government practice and recommended that approval of the Badger procurement system be withheld pending satisfactory implementation of the DCAS recommendations contained therein.
- As H-Coal was Badger's first U. S. Government construction contract, formal systems and procedures did not exist that were in compliance with the FPR's or DOE PR's.
- Corrective action was initiated by Badger to comply with the DCAS recommendations.
- H-Coal construction was 80 percent complete at the time the DCAS report was issued.
- Time remaining on the project did not allow for the generation, approval and implementation of these procurement systems and procedures.

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5. Labor Productivity

GAO Comment: The general construction contractor (construction management contractor) adjusted worker productivity data to increase the productivity basis. GAO includes a comment made by one private industry official that professes to state the real productivity level prior to this adjustment.

Response: We believe this data adjustment comment to be unfounded. Adjustments to productivity data are made periodically during Badger construction projects, but only to update the measurement basis to reflect recent estimates for increased work.

We do not believe that the use of an opinion by one private industry official is appropriate in a report of this nature.

6. Coordination Between Design, Procurement and Construction

GAO Comment: The design contractor stated that no realistic construction schedules were provided. Without a meaningful construction schedule, the design contractor had no alternative but to expedite the procurement of all equipment. (pages 43 and 44)

Response: Realistic (or meaningful) construction schedules cannot be generated without the knowledge of what is to be erected. The lack of basic design information, which is essential to the generation of construction schedules, was a continual problem experienced by BPI throughout the H-Coal project, and it cannot be understated.

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Direct coordination between the design contractor and erection contractor was minimal during most of the project. Other major design-related difficulties experienced by BPI were:

- o Design completion had not progressed far enough prior to the start of H-Coal erection, as stated on page 25 of the draft report.
- o Design changes were made without proper regard for erection progress. This had a significant impact on labor productivity.
- o Design changes were abnormally excessive and required a large representation of designer personnel at the site to assist in design interpretations and to expedite solutions to design problems.
- o Delivery schedules for designer procured materials were not provided to the erection contractor on a timely basis to allow for needed field planning for receipt and use.

The above makes invalid the contention, on the part of the design contractor, that he had no alternative but to expedite the procurement and delivery of all equipment, as he lacked a meaningful construction schedule. This situation contributed to the several GAO comments on pages 44, 45 and 46 relating to material and equipment controls.

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7. Material Handling

GAO Comment: Expensive equipment and materials were often left outside in an unprotected condition. (page 46)

Response: We agree that this condition did exist and that BPI experienced serious material handling and storage problems for a period of time during H-Coal erection. However, BPI did initiate corrective action to rectify the situation and implemented the necessary controls to safeguard against its recurrence.

8. Rental of Construction Equipment

GAO Comment: All H-Coal construction equipment was rented and rental costs of some items are over one and one-half times the purchase price. FPR's were violated because erection contractor rented this equipment from another subsidiary of his parent company. (pages 49 and 50)

Response: The GAO comments do not properly address the H-Coal rental equipment situation. Specific information on this matter may not have been available to GAO's field audit personnel at the H-Coal site. Therefore, this specific information is provided below:

- o Initial determination of H-Coal construction equipment requirements were based upon a project duration of 18 months, which showed equipment requirements, in most cases, to be fewer than twelve months.

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- o Based upon equipment requirements of fewer than twelve months, a decision was made to rent rather than buy, that being the most economical means of acquiring the needed construction equipment for the projected period of use.
- o The normal Badger business practice for equipment rental was employed in determining the source and price of the necessary construction equipment. This is more fully explained below.
- o The price of rental equipment was addressed separately with ASFI during negotiation. Badger's method was found to be acceptable and the agreed upon amount (intent of the parties) was expressed as an element of the complex fixed fee that was finally negotiated between Badger and ASFI.
- o The H-Coal project schedule was ultimately extended to 36 months, which, if known at the start, would have affected the initial rent or buy decision.

The GAO comments relating to excess of rental cost over purchase price are not valid when the above-stated aspects are taken into consideration.

On March 2, 1980, Badger received a DCAA Form 1, Notice of Contract Costs Suspended and/or Disapproved, advising that the amount of \$887,285.19 was suspended due to

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contractor's failure to compute costs for company-owned equipment in accordance with FPRI-15.205-34 (g). Badger responded to this cost suspension to DOE by letter No. BPI-DJC-01-001 dated June 18, 1980. In essence, this letter identifies the main elements of the suspended amount, explains the Badger method of handling rental of its equipment and described how this method was applied to the H-Coal project. In abbreviated form, the Badger letter stated the following factual information:

- o Badger maintains specifically listed construction equipment tools of the trade.
- o Badger employs this equipment where necessary, on client projects at predetermined rental amount charges.
- o Badger rental charges are lower than market.
- o Competitive quotations for rental of equipment are solicited and Badger equipment utilized only when rental charges are lower than solicited rental prices.
- o On H-Coal, the solicitation record shows that of 229 rental items solicited, 225 quotes were received, four items being no bid.
- o Badger rental amounts were less than the low bidder prices received as shown on the following page:

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1. Price of low bidder responses	\$1,010,349
2. Badger rental amount charged variance	<u>853,042</u>
	\$ 248,707

We feel very strongly that the information depicted above is reflective of good business judgment in this area and that the amounts charged by Badger for construction equipment rentals are not only fair, and reasonable, but reflect the original intent of the parties as agreed upon. That this method does not comply with the appropriate FPR does not alter the facts, nor reduce the obvious benefits received by the U. S. Government through its employment.

### 9. Quality Control/Assurance

GAO Comment: Quality control/assurance has been inadequate throughout the construction of the H-Coal project. Not until the last year of the project was an organized quality control/assurance function established and even then its effectiveness was undermined because both functions were staffed and managed by the general construction contractor. (page 50)

Response: We do not believe that these comments are justified and wish to provide the following information as clarification:

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- o For the first two years of the project, Badger's quality control was considered adequate by the construction management contractor quality assurance representatives.
- o At the outset, Badger submitted its Field Quality Control Program to the construction manager.
- o Monthly project reports indicate no major quality concerns or problems.
- o Prior to formally assuming construction management responsibility, Badger initiated a jobsite quality program audit. The report resulting from this audit, which was submitted to DOE in October 1978, clearly identified several quality program deficiencies and set forth the required corrective action.
- o A quality program implementation plan was presented to DOE and the Management Advisory Committee (MAC) in December 1978. This plan was approved and implemented.
- c When implemented in 1979, Badger's quality programs were monitored, audited, checked and verified by DOE and also congressional staff representatives. The implemented Badger quality programs were considered acceptable by these parties.

DOE makes specific comment of defective field-erected piping. This problem was not known until Badger assumed the responsibility for project quality assurance and brought it to

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the attention of DOE. The work had previously been acceptable to the project manager. Corrective action was taken, as a result of Badger QA surveillance. Similarly, the problem of defective high-pressure pipe was identified by Badger quality assurance personnel. In each case, radiographic inspection acceptance criteria, established by the former project manager, had to be amended.

#### 12. Erection/Construction Management Staffing

**GAO Comment:** The general construction contractor added a construction management team composed of a maximum of 22 people. This established two separate groups at the site from the same parent company, one to provide oversight and direction to the other. One of the private participants questioned the need for both groups. (page 53)

**Response:** We do not believe this situation to be either clearly stated or properly understood. In the context as presented, the GAO comment gives rise to question the identity of the general construction contractor and seems to be misleading. The following points are presented to clarify the BPI erection/construction management relationship in H-Coal:

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- o DOE added BPI as the construction management contractor.
- o The duties and responsibilities of the H-Coal construction management contractor encompassed overall H-Coal contractor coordination, monitoring and quality assurance and supplanted those functions formerly performed by ASFI.
- o The duties and responsibilities of the construction management contractor are clearly without the scope of the erection contractor as contractually defined.
- o The BPI erection and construction management groups did not perform redundant functions.

It is hoped that the above information clarifies the situation for the purpose of the draft report. Also, we must again object to the use of unsubstantiated comments by third parties, which in this case, could lead to unnecessary confusion.

This concludes the Badger comments relating to the GAO draft report on the H-Coal project.

GAO NOTES

The Badger Energy, Inc., letter contains 10 specific responses to the contents of the report. The following topics are our comments to each of these responses and they are numbered in sequence to the Badger letter:

1. Progress measurement

We do not believe Badger's response addressed the point raised in this report. Although Badger has employed man-hours a ton as a unit of measurement for many years, this system is not used by many other U.S. construction contractors. As stated in the report, DOE and its hired consultants were unfamiliar with this system and as a result were unable to do proper monitoring of construction progress. Furthermore, several industry officials told us the measurement system employed by Badger was not the best for measuring progress and they preferred "footage" as the unit of measure.

2. Subcontracts and subcontracting practices

We reaffirm our point that subcontracting on the H-Coal project was excessive (20 percent) and some unacceptable contracting practices were followed (see pp. 23 and 24). Contractor officials stated the normal level of subcontracting on projects like H-Coal and EDS is 5 to 10 percent. These same officials told us the level of subcontracting on the H-Coal project was highly uncommon.

DOE officials told us they became aware after the unacceptable subcontracting practices were discussed in our report, and that they were not satisfied with the subcontracting activity that occurred on the H-Coal project. DOE and DCAA also confirmed they did not closely monitor subcontracting activities due inadequate manpower. This is confirmed by the absence of audit reports on subcontracting and other contract activities.

3. Inconsistency in subcontracting practices

The listing of questionable subcontracting practices was compiled based on a detailed audit of seven subcontracts. The time consuming process of reviewing disorganized and otherwise incomplete files, and attempts to obtain pertinent data from other sources, precluded our review of additional subcontracts. These particular subcontracts were selected because certain project officials told us that irregularities had occurred in their bidding, pricing, awarding. The leads provided by these officials were substantiated in

our audit. For example, the following is in response to the Badger statement regarding the \$2 million noncompetitive subcontract.

--The Badger bid comparison showed only four firms were solicited to bid and only one of the four did not respond to the solicitation. Two of the three subcontractors who did respond were disqualified on the technicality that their bids were not lump-sum proposals. The remaining firm was awarded the subcontract on the basis of its lump-sum proposal. The invitation to bid requested a lump-sum proposal but alternatively permitted a proposal on another basis if a lump-sum bid was not feasible. A review of the proposals that were disqualified showed these proposals may have been considerably, more reasonable, even on a cost-plus-fee-basis, than the lump-sum bid which was accepted by Badger. It was necessary for us to search the files of another project participant to obtain copies of the disqualified contractor's bids, because copies were not available in Badger's files and their officials were not otherwise able to produce them.

#### 4. Construction management change order approval

Our statement referred to in the Badger response has been modified to more accurately reflect our position on the subject of change order approval. Our intent in this section of the report is to show that DOE failed to assure that adequate controls were exercised over the change order processing procedure, and that the procedures used did not always fully comply with the Federal Procurement Regulations.

#### 5. Labor productivity

We revised this segment of the report to remove any productivity index figures computed by Badger and those estimated by other project participants. A wide difference of opinion exists on such data. As stated in the Badger response, they feel their adjustments to productivity data were made only to reflect estimates for increased work. Others involved in the project stated otherwise. Some project officials openly told us they had no faith in the data being reported in Badger's monthly construction reports. DOE's monitoring of the Badger data was limited due to staffing and even their construction consultants had problems in performing such tasks because of Badger's irregular measurement system (man-hours per ton).

6. Coordination between design, procurement, and construction

We concur with Badger's response statement that a lack of coordination between design, procurement, and construction activities was present on the H-Coal project. Contractors prefer to blame each other instead of pulling their efforts toward orderly construction. There was absence of overall leadership from the Government through DOE and from private industry through the original firm in charge of construction management. DOE's consultants once recommended that because design was not sufficiently completed the project should be stopped for 6 months. DOE rejected this idea. Nevertheless, the facts remain the same--equipment and materials were expedited to the site, inventory records were not properly prepared and maintained, controls over equipment and materials at the site were poorly handled, and there was abusive handling of these items at the site.

We concur that Badger did take corrective action to improve material handling and controls, but this occurred after construction was over half completed and the damage to expensive materials had already occurred. Furthermore, the lack of proper inventory controls at the beginning of the project made it impossible to reconcile the ending inventories to the total materials purchased and used in the construction of the H-Coal plant.

8. Rental of construction equipment

We are aware of the circumstances relating to the rental agreements between (1) Badger and Ashland and (2) Badger and DOE. The point we are raising in this report is that the latter agreement violates Federal Procurement Regulations on rental equipment for construction projects. The regulations state that equipment will be purchased if the rental cost approximates the cost of ownership or if the item of equipment costs less than \$1,000. This regulation was not followed on the H-Coal project and all equipment was rented. We also understand that originally the project's scheduled duration may have showed that rental cost for equipment would not exceed the cost of ownership. The regulations also state, however, that when rental paid for an item of equipment equals 75 percent of its appraised value, the rental shall cease and the item will remain available for use under the contract. On the basis of our review of rental costs on the H-Coal project, it was apparent that the rents charged by Badger far exceeded the limitations allowed by regulations. When we finished our review, DCAA

was in the process of determining the total amount of excess rental charges.

9. Quality control/assurance

We disagree with Badger's claim that its quality control efforts were adequate during the first 2 years of construction. As in other responses, Badger relies on the fact that no other project participant voiced a complaint about their practices and the quality area was checked, audited, or approved by various parties. However, the \$2.3 million reweld program as well as other quality problems showed that the quality control efforts of Badger and the quality assurance program under Ashland failed to properly assure the construction work, especially the welding, which was being done according to codes.

In a January 1979 memorandum to DOE, Badger's Project Construction Director cited the following quality problems.

<u>Quality area</u>	<u>Problem</u>
Socket welds	BPI (Badger) did not uniformly follow the fit-up recommendations (welding code) during construction.
Welder qualification	Through procedural errors and incorrect radiography, all welders' qualifications are invalid for 2 inches and below buttwelds.
Unqualified welders	Due to above, many 2 inches and below buttwelds were joined by unqualified operators.
Traceable markings	Code requires that all welds be traceable back to the operator performing such weld, by either marking each pressure containing weld with identification symbol of the operator or filing of appropriate records. This requirement was not consistently and uniformly performed by the individual operators (welders) on large bore 2-1/2 inches and above buttwelds.

The above quality problems occurred under Badger's supervision and the fact that they went undetected for a

long period of time showed the poor oversight exercised by DOE and the firm in charge of quality assurance. The problems cited in the second and third areas resulted in the costly reweld program and the redoing of over 1,000 welds as reported on page 33.

10 and 11. Comments 10 and 11 were excluded in Badger's letter to us.

12. Erection/construction management staffing

There was a considerable investment in management personnel for the H-Coal project and we believe the information presented on pages 33 and 34 is accurate. Upon reorganization of contractors, Ashland retained its personnel and Badger added a construction management team of up to 22 people to do the duties originally assigned to Ashland. Badger's response takes exception to our point about two separate groups from their company being redundant in management effort and states we are using comments of unsubstantiated third parties.

In the January 1979 minutes of the Management Advisory Committee (includes the project's financial participants), the following remarks were made in the presence of the Badger official in charge at the H-Coal pilot plant site by two of the project's financial participants.

--The Conoco representative indicated that the 2.5-percent progress for the period was devastating and expressed concern over the fact that the great improvement which was to have taken place by the addition of the Badger management people has just not occurred to any degree. Each month Badger reports that reorganization is taking place, key people are being changed and are changed again by the following month. Productivity remains low and Badger does not provide answers regarding where they are or what is wrong.

--A Standard Oil (Indiana) representative also expressed disappointment in Badger's performance and questioned the need for two separate teams.

(951525)

